2001

VCO/HB-01

VCO Designer's Handbook

WHAT'S INSIDE

- *How VCO Performance Parameters Affect Each Other*
- *VCO Terms - Defined!*
- *New Line Stretchers Ease VCO Load-Pulling Tests*
- *Get Answers To Frequently Asked VCO Questions*
- *Use Our Quick Selection Guide To Choose Your VCO...Fast!*
- *Discover Practical Techniques For Reducing Power Supply Noise*
- *Communicate Custom VCO Needs For Mini-Circuits fast response*

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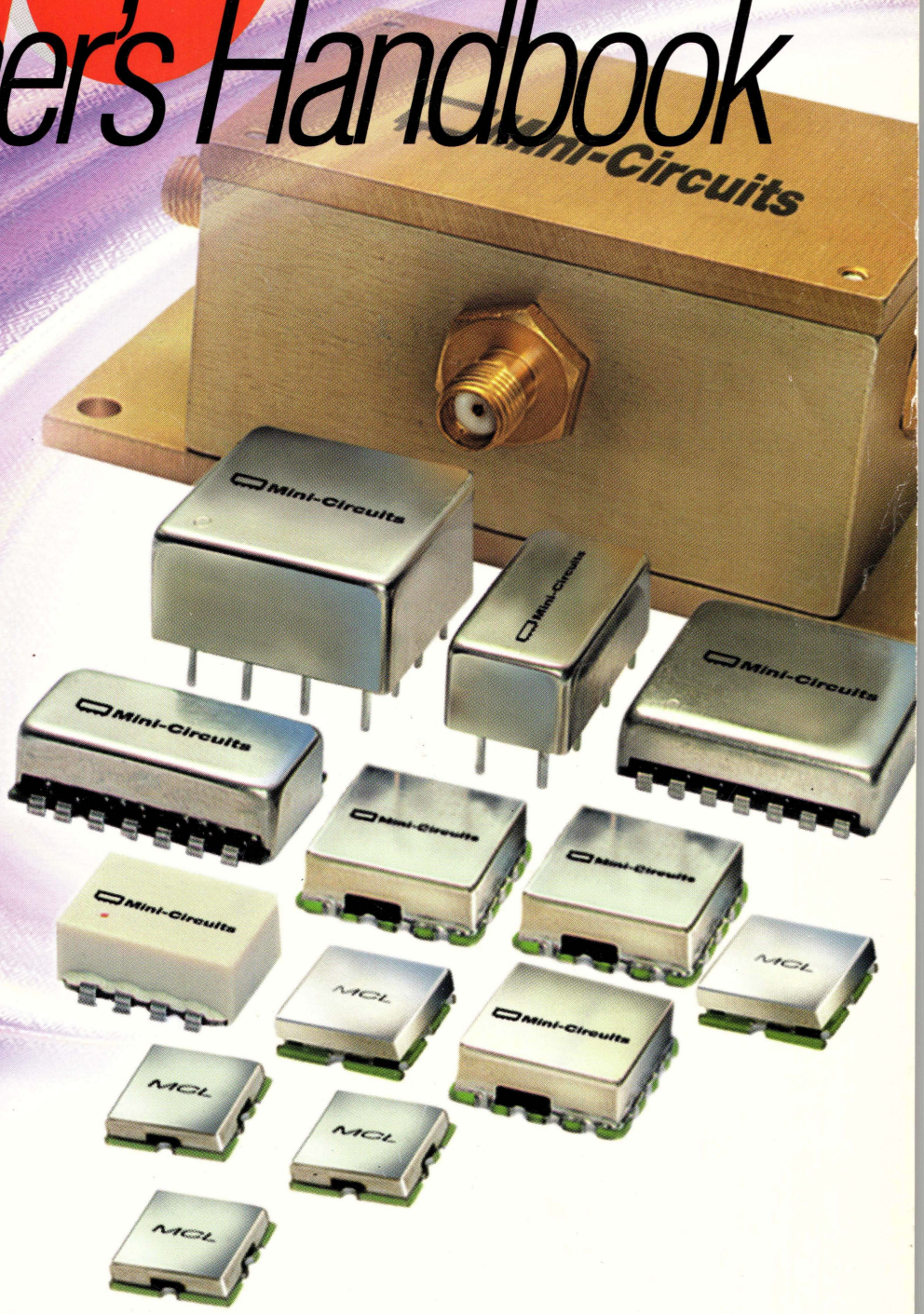

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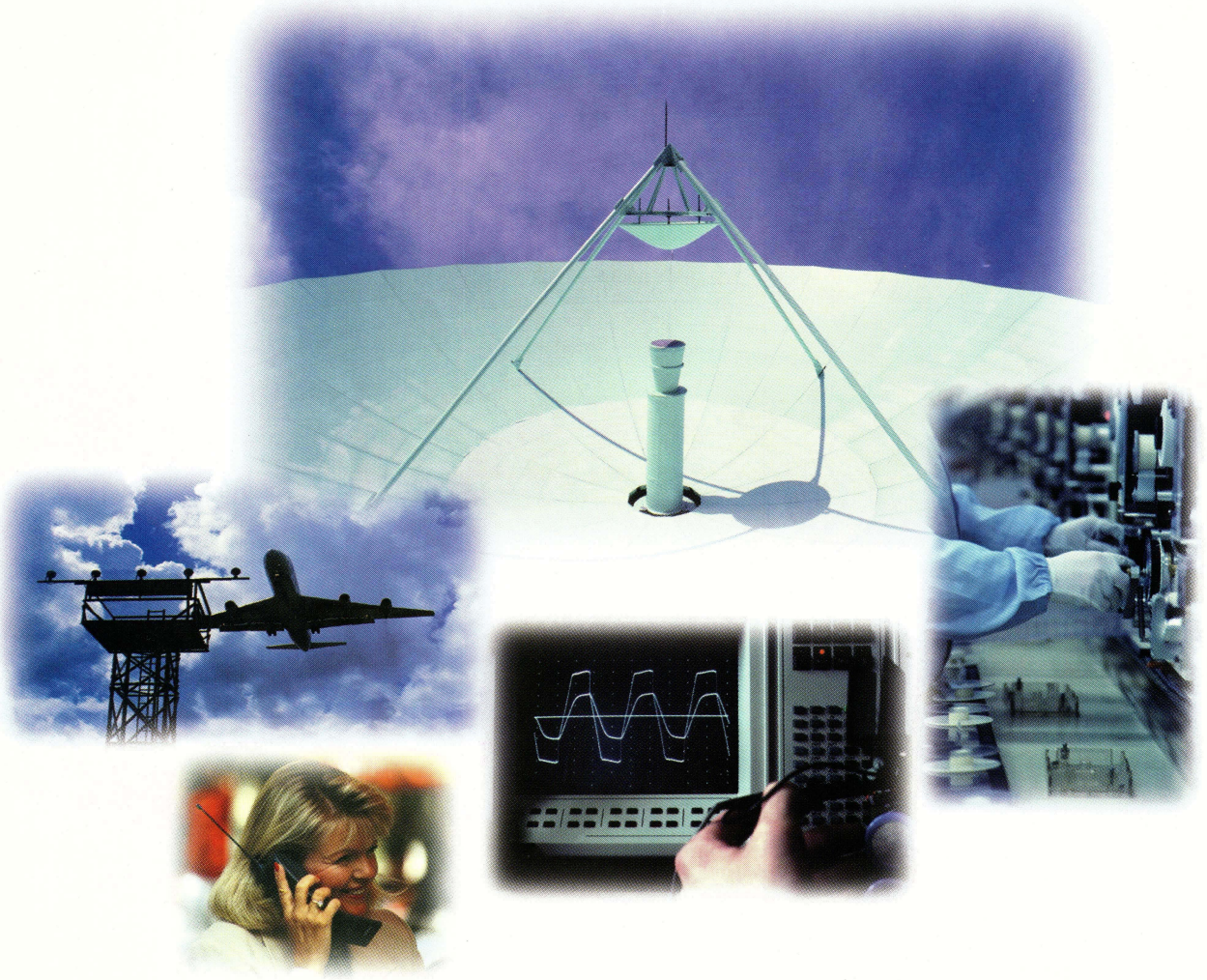

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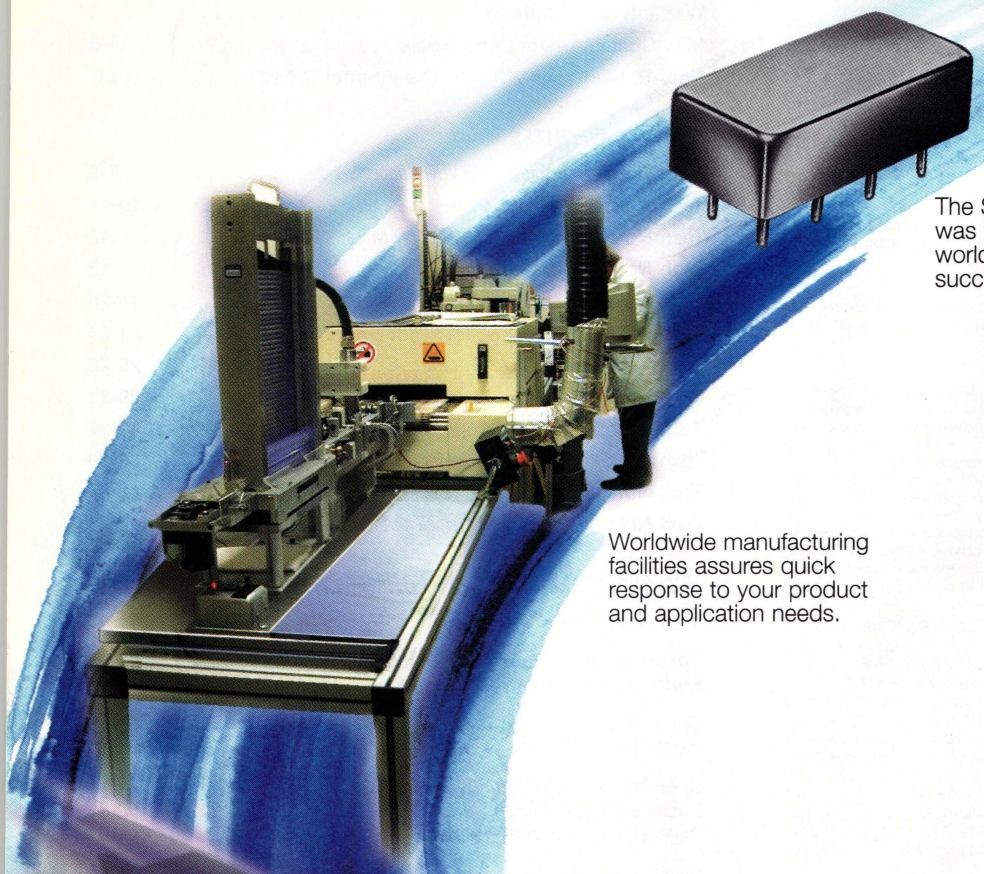

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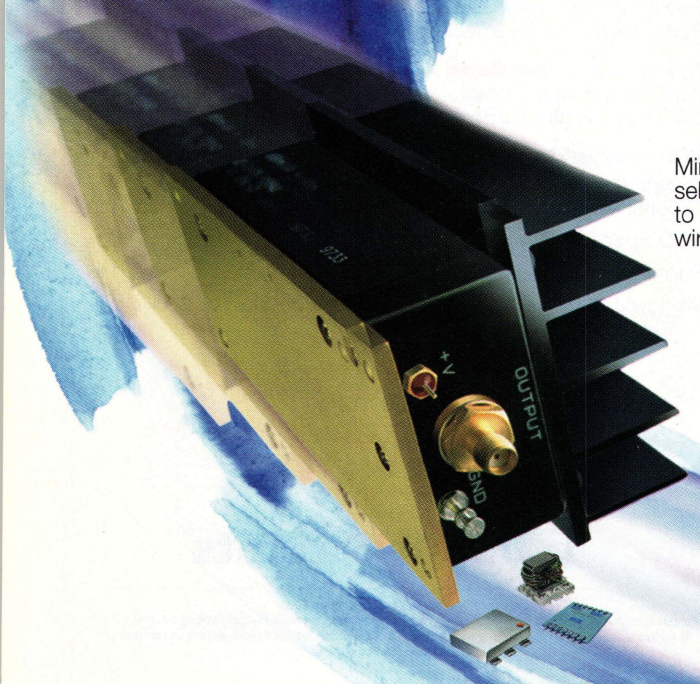

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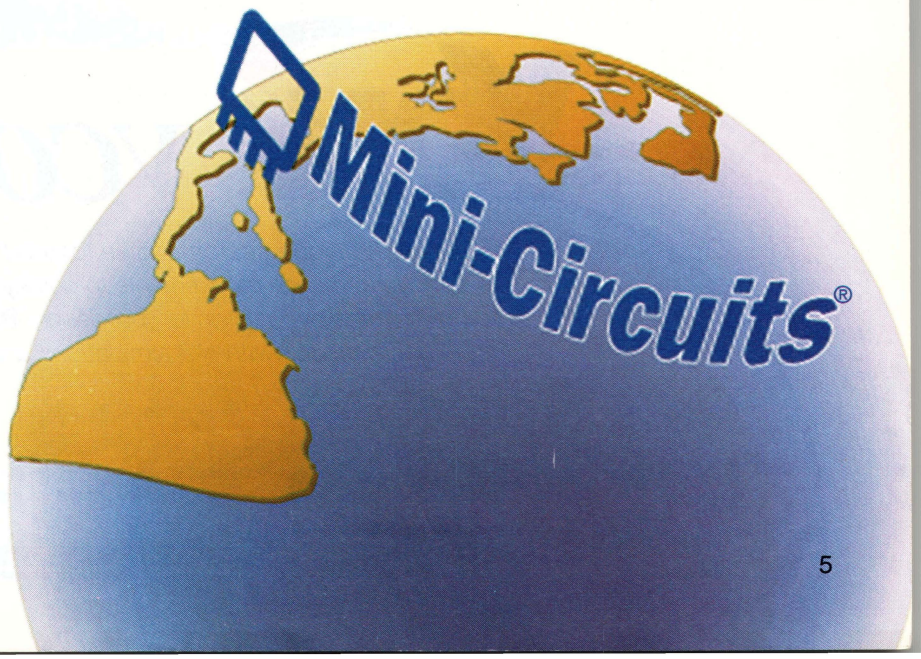

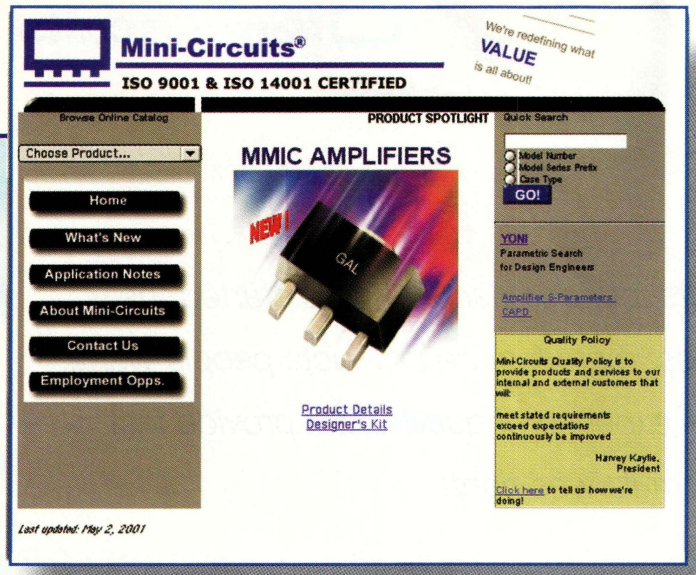

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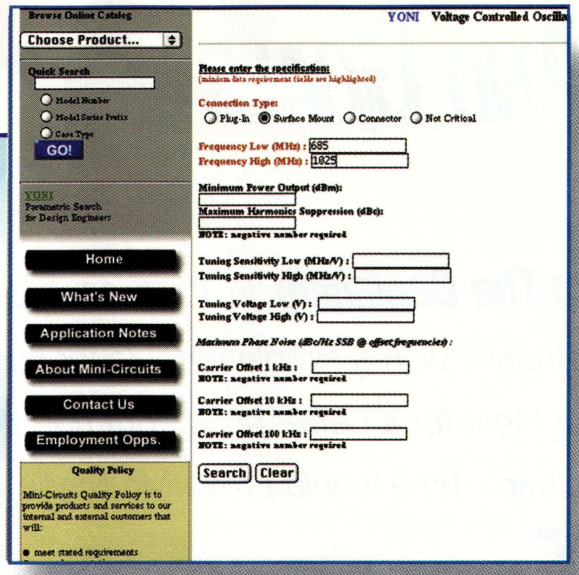

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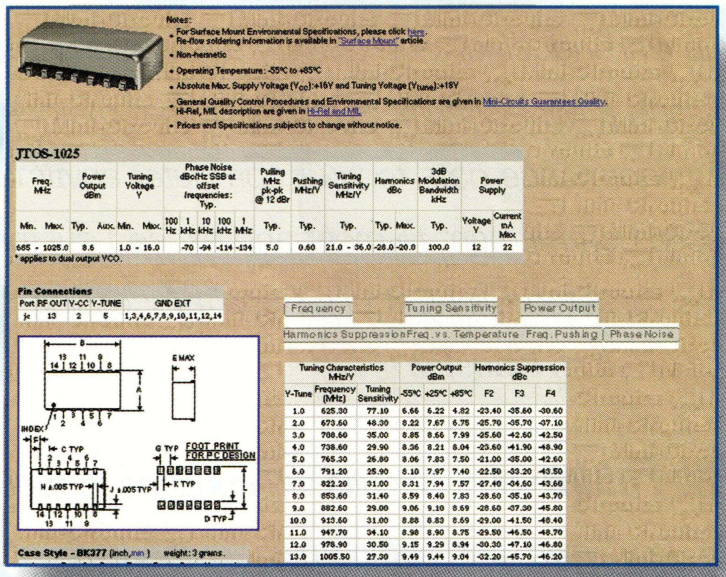

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Click on the reference number to see Performance Data and Graph.

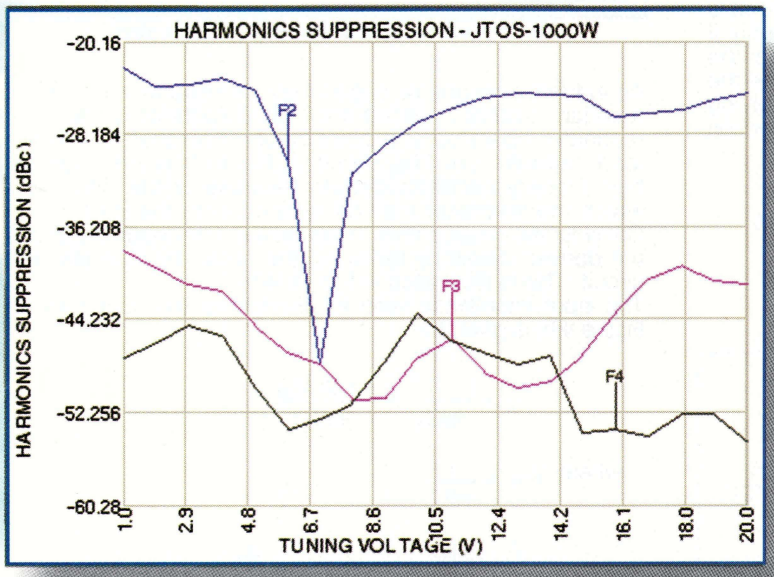
Reference No.	Freq. MHz	Power Output dBm	Tuning Voltage V	Phase Noise dBc/Hz SSB at offset frequencies: Typ.					Pulling MHz pk-pk @ 12 dBr	Pushing MHz/V	Tuning Sensitivity MHz/V	Harmonics dBc		3dB Modulation Bandwidth kHz	Power Supply		Case Style	Conn-ection	No
	Min. Max.	Typ. Max.	Min. Max.	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	Typ.	Typ.	Typ.	Typ.	Max.	Typ.	Voltage V	Current mA Max			
JTOS-765	485 - 765.0	8.0	1.0 - 16.0		-75	-98	-118	-138	2.0	0.50	20 - 30.0	-30.0	-20.0	100.0	12	20	BK377	jc	*,G
JTOS-1000W	500 - 1000.0	7.0	1.0 - 18.0		-73	-94	-114	-134	5.0	1.00	30 - 40.0	-26.0	-20.0	100.0	12	25	BK377	jc	*,G
ROS-765	485 - 765.0	6.0	1.0 - 16.0		-74	-95	-115	-135	2.0	0.50	10 - 40.0	-27.0	-14.0	100.0	12	22	CK60S	kg	*,G
JTOS-850VW	400 - 850.0	8.0	0.5 - 18.0		-74	-96	-116	-136	6.0	1.5	15 - 80.0	-20.0		185.0	5.0	20	BK377	jc	E,H,
ROS-550PV	450 - 550.0	6.0	0.5 - 5.0		-81	-104	-124	-144	3.0	0.50	30 - 60.0	-15.0		8000.0	5.0	15	CK60S	kg	E,H,
ROS-608960/1	449 - 608.0	4.0	0.5 - 5.0		-82	-108	-128	-148	3.5	0.80	20 - 100.0	-22.0		7000.0	5.0	20	CK60S	kg	
ROS-608470A/1	403 - 587.0	6.0	0.5 - 5.0		-81	-104	-124	-144	3.0	0.50	30 - 60.0	-15.0		8000.0	5.0	15	CK60S	kg	
ROS-605477B/2	353 - 605.0	8.5	0.5 - 12.0		-77	-98	-119	-139	0.50	0.50	9 - 42.0	-21.0	-12.0	120.0	12	25	CK60S	kg	
ROS-639466B/1	495 - 639.0	8.0	1.0 - 10.0		-76	-103	-125	-143	1.00	1.1	14 - 23.0	-22.0	-12.0	3000.0	5.0	25	CK60S	kg	
ROS-590466B	498 - 590.0	3.0	0.5 - 10.0		-90	-112	-134	-151	0.60	0.15	9 - 17.0	-22.0	-16.0	10000.0	5.0	20	CK60S	kg	
ROS-770440G	450 - 770.0	6.0	1.0 - 16.0		-73	-94	-114	-135	1.5	0.90	11 - 40.0	-24.0	-15.0	100.0	12	17	CK60S	kg	
JTOS-860R4B5	481 - 860.0	7.5	1.0 - 15.0		-74	-102	-126	-149	7.0	3.0	18 - 56.0	-25.0	-15.0	10000.0	12	20	BK377	jc	
JTOS-997D579/6	423 - 997.0	7.0	1.0 - 19.0		-76	-97	-117	-137	9.6	4.8	28 - 47.0	-10.0		100.0	5.0	15	BK377	jc	
JTOS-753D124/2	491 - 753.0	10.0	0.5 - 6.0		-70	-91	-112	-135	4.1	3.1	36 - 55.0	-40.0		750.0	5.0	30	BK377	jc	
JTOS-835D769/2	386 - 835.0	9.0	1.0 - 15.0		-73	-94	-115	-135	4.4	1.3	25 - 50.0	-23.0		100.0	10	25	BK377	jc	

* applies to dual output VCO.

Pin Connections - see case style outline drawing

Port	RF OUT	V-CC	V-TUNE	GND EXT

❸



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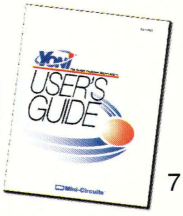


OSCILLATOR FUNDAMENTALS

An oscillator circuit can be modeled as shown in Figure 1 as the combination of an amplifier with gain A(jω) and a frequency dependent open loop gain H(jω) = βA. The general expression is

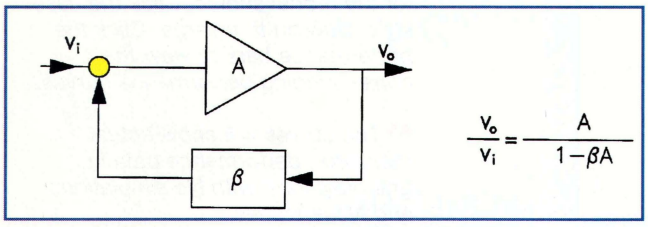
$$\frac{V_O}{V_i} = \frac{A}{(1-\beta A)}$$

which states that the system will oscillate, provided βA >= 1. At the frequency of oscillation, the total phase shift around the loop must be 360 degrees, and the magnitude of the open loop gain must be unity. The common emitter circuit provides 180 degree phase shift. If the circuit is used with feedback from collector to base, the feedback circuit must provide additional 180 degree phase shift. If a common base circuit is used, there is no phase shift between the emitter and collector signals, the feedback circuit must provide either 0 degree or full 360 degree phase shift.

Although the model shown in Figure 1 can be used to analyze and determine the necessary and sufficient conditions for oscillation, it is easier to use the model shown in Figure 2 where the analysis is performed in terms of a negative resistance concept. This is based on the concept that a tuned circuit, once excited, will oscillate continuously if there is no resistive element present to dissipate the energy. It is the function of the amplifier to generate the negative resistance or maintain oscillation by supplying an amount of energy equal to that dissipated. The selection of the circuit topology is dictated by several factors:

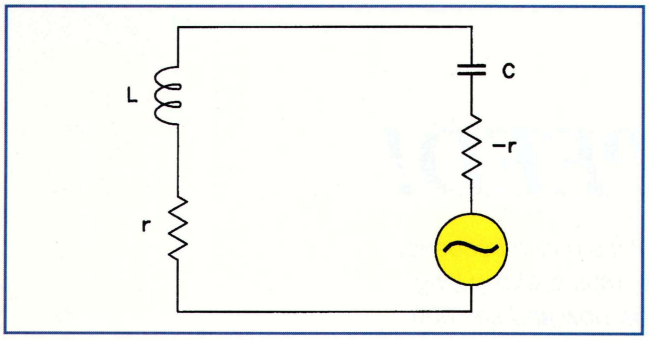
(a) Frequency of oscillation
(b) Tuning range when used as VCO
(c) Choice of transistor, and
(d) Type of resonator.

Figure 1



An oscillator may be modeled as the combination of an amplifier and a feedback loop

Figure 2

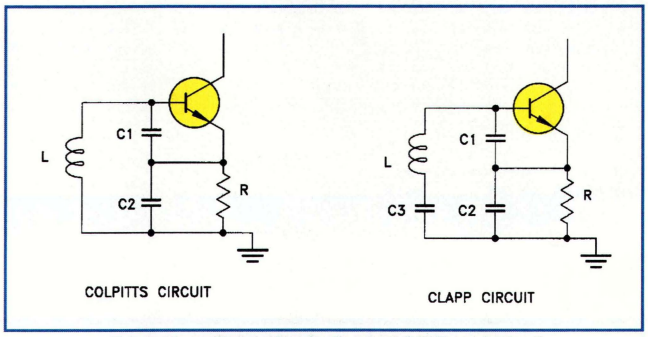


An oscillator may be modeled using a negative resistance concept

EXAMPLES OF OSCILLATOR DESIGN

A bipolar transistor with capacitances between the base and emitter, and the emitter and ground, can be used to generate a negative resistance. Examples of these circuits are shown in Figure 3.

Figure 3



Form of oscillator circuit discussed (RF equivalent)

An inductive resonator circuit may be used in any parallel resonant oscillator circuit such as Colpitts or Clapp. The resonator operates at a point where it resonates with the load capacitance. The circuit of Figure 3 is preferred for high stability oscillator circuits because of the ease with which the resonator may be isolated from the load.

Consider the circuit shown in Figure 4(a). The design equations are derived below by replacing the circuit by its equivalent circuit. This is illustrated in Figure 4(b).

The input impedance seen to the right of the dotted line in Figure 4(b) is given by

$$V = \frac{i}{j\omega C_1} + \frac{i + g_m V_{be}}{j\omega C_2}$$

where $V_{be} = \frac{i}{j\omega C_1}$

$$\frac{V}{i} = \frac{1}{j\omega C_1} + \frac{1}{j\omega C_2} - \frac{g_m}{\omega^2 C_1 C_2}$$

The quantity $(g_m/\omega^2 C1.C2)$ is negative indicating a negative resistance component and therefore in order to maintain oscillations we must have

$$r < \frac{g_m}{\omega^2 C_1 C_2}$$

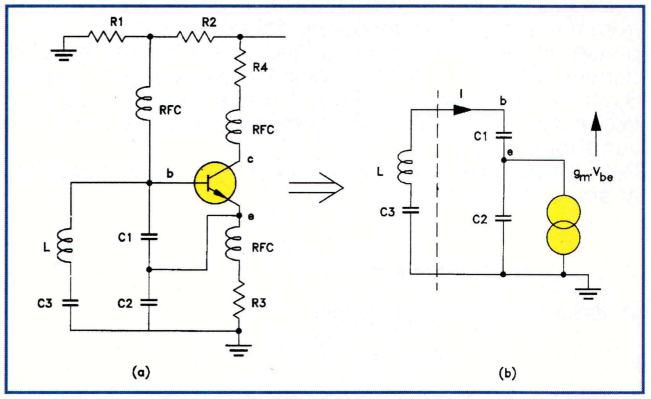
where r is the series resistance of the resonator.

The frequency of oscillation is given by

$$(\omega^2)L = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

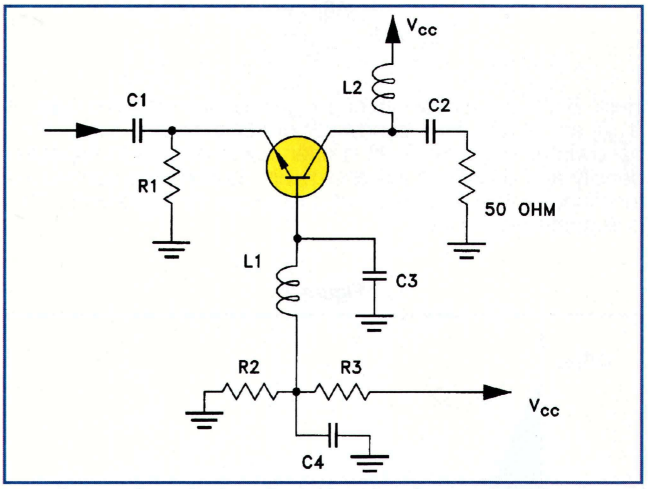
The ratio C_1/C_2 is selected to be greater than 1 so that the circuit has sufficient loop gain for start up condition at the lowest operating temperature. A VCO is obtained by replacing a fixed capacitor such as C3 with a varactor. The bipolar transistor with an inductive reactance between the base and the ground can also generate a negative resistance (See Figure 5). This topology is preferred at higher frequencies. The oscillator is obtained by adding a tank circuit as shown in Figure 6.

Figure 4(a) and 4(b)



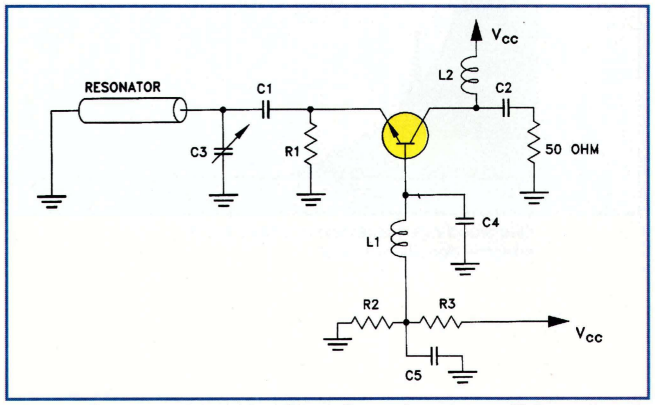
Oscillator design evaluation for CLAPP circuit

Figure 5



Common base circuit configured for generating negative resistance

Figure 6



Common base circuit configured as an oscillator

TUNING SENSITIVITY CHARACTERISTICS

There are two basic types of varactors: Abrupt and Hyperabrupt. The abrupt tuning diodes will provide a very high Q and will also operate over a very wide tuning voltage range (0 to 60 V). The abrupt tuning diode provides the best phase noise performance because of its high quality factor.

The hyperabrupt tuning diodes, because of their linear voltage vs. capacitance characteristic, will provide a much more linear tuning characteristic than the abrupt diodes. These are the best choice for wide band tuning VCOs. An octave tuning range can be covered in less than 20 V tuning range. Their disadvantage is that they have a much lower Q and therefore provide a phase noise characteristic higher than that provided by the abrupt diodes.

For a varactor diode, the capacitance is related to the bias voltage by the following equation:

$$C = \frac{A}{(V_R + \phi)^n} \qquad \text{.....(1)}$$

where A is a constant, V_R is the applied reverse bias voltage, and ϕ is the built-in potential which is 0.7 for silicon diodes, and 1.2 V for Gallium Arsenide diodes. For the analysis that follows, we may write

$$C = \frac{A}{V^n} \qquad \text{..... (2)}$$

where A is the capacitance of the diode when V is one volt and n is a number between 0.3 and 0.6, but can be as high as two for an abrupt junction. The tank circuit of a typical VCO has a parallel tuned circuit consisting of an inductance L, a fixed capacitance C_f, and a varactor diode C. The frequency of oscillation can be written as

$$\frac{1}{\omega^2} = L(C_f + AV^{-n}) \qquad \text{..... (3)}$$

Let ω_o be the angular frequency of the unmodulated carrier and V_o and C_o be the corresponding values of V and C. Then from Equation (3) we have

$$L = \frac{1}{\omega_o^2 (C_f + C_o)} \qquad \text{.....(4)}$$

If V_o is modulated by a small voltage δV, the carrier will be deviated by a small frequency $\delta\omega$.

$$(\omega_o + \delta\omega)^{-2} = L\,[C_f + A(V_o + \delta V)^{-n}]$$

Substituting for L and rearranging, we have

$$\left(1 + \frac{\delta\omega}{\omega_o}\right)^{-2} = \frac{C_f + C_o\left(1 + \frac{\delta V}{V_o}\right)^{-n}}{C_f + C_o}$$

The oscillator tuning sensitivity K can therefore be written as

$$K_1 = \frac{d\omega}{dv} = \frac{n\omega_o}{2V_o}\left(\frac{C_o}{C_f + C_o}\right)$$

The units of K_1 are Hertz/Volt.

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CHARACTERIZING PHASE NOISE

The term phase noise is phase fluctuations due to random frequency fluctuations of a signal. Frequency stability is a measure of the degree to which an oscillator maintains the same value of frequency over a given time. This may be specified in a number of ways. Three commonly used terms for describing frequency stability are used here. An ideal sine wave oscillator may be described by

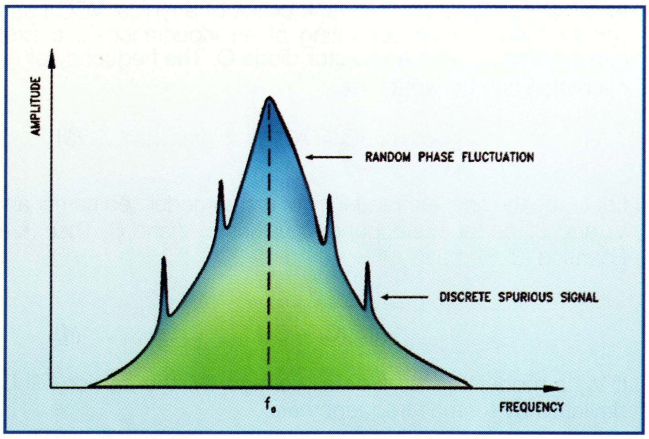
$$V(t) = V_o \mathrm{Sin} 2\pi f t$$

Here, V_o is the nominal amplitude of the signal, and f is the nominal frequency of oscillation. The instantaneous output of an oscillator may be represented by

$$V(t) = V_o \{1 + A(t)\} \mathrm{Sin} \{2\pi f t + \theta(t)\}$$

where A(t) and θ(t) represent the amplitude and phase fluctuations of the signal respectively. The phase term may be random or discrete and could be seen on the spectrum analyzer. As shown in Figure 1 there are two types of fluctuating phase terms. The first, the discrete signals called spurious, appear as distinct components in the spectral density plot. The second term, random in nature, appears as random phase fluctuations and is commonly called phase noise.

Figure 1



Spectrum analyzer display of phase noise

The source of phase noise in an oscillator is due to thermal and flicker or 1/f noise. Most oscillators operate in saturation. The AM noise component is usually 20dB lower than the phase noise component. In the discussion that follows, we will assume that A(t)<<1.

Many methods are used to characterize phase noise of an oscillator. Essentially, all methods measure the frequency or phase deviation of the source under test in either frequency or time domain. Since frequency and phase are related to each other, all these terms are also related. One of the most common fundamental descriptions of phase noise is the one sided spectral density of phase fluctuations per unit bandwidth. The term spectral density describes the RMS phase distributions as a continuous function, expressed in units of RMS phase per unit bandwidth. The phase noise of an oscillator is best described in the frequency domain where the spectral density is characterized by measuring the noise sidebands on either side of the output signal center frequency. Single sideband phase noise is specified in dBc/Hz at a given frequency offset from the carrier. The frequency domain information about phase or frequency is contained in the power spectral density $S_{\Delta\theta}(f)$ of the phase or in the power spectral density $S_{\Delta f}(f)$ of the frequency. Here, f refers to the modulation frequency or offset frequency associated with the noise-like variations in θ(t).

Peak phase modulation Δθ and peak frequency modulation Δf are related as follows:

$$\Delta\theta_{peak} = \left(\frac{\Delta f_{peak}}{f}\right)$$

In terms of rms values, we have

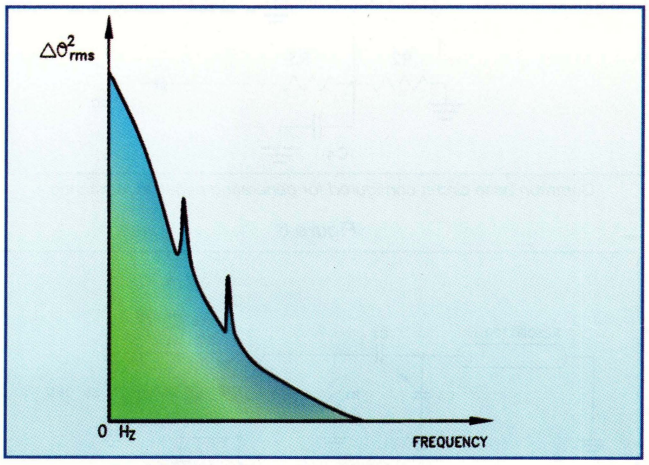
$$\Delta\theta_{rms} = \frac{(\Delta f_{rms})}{f}$$

The one sided spectral distribution of the phase fluctuations per Hz bandwidth is $S_{\Delta\theta}(f)$

$$S_{\Delta\theta}(f) = \frac{(\Delta\theta_{rms})^2}{BW}$$

Here, BW is the bandwidth of $\Delta\theta_{rms}$ measurement. The units of $S_{\Delta\theta}(f)$ are radian^2 Hz^{-1} bandwidth or dB relative to 1 rad^2 Hz^{-1} bandwidth. The term $S_{\Delta\theta}(f)$ is often referred to as the spectral density and describes the energy distribution as a continuous function, expressed in units of energy per Hz bandwidth. This is illustrated in Figure 2.

Figure 2



One sided representation of phase noise spectral density of signal

Similarly, one sided spectral distribution of the frequency fluctuations per Hz bandwidth is $S_{\Delta f}(f)$ where

$$S_{\Delta f}(f) = \frac{(\Delta f_{rms})^2}{BW}$$

Here, BW is the bandwidth of Δf_{rms} measurement. The units of $S_{\Delta f}(f)$ are (rad sec^{-1})^2 Hz^{-1} bandwidth. It is also common to characterize the noise performance of a signal as the ratio of the sideband power associated with phase fluctuations to the carrier power level. If the measure is denoted by S_C

$$S_C(f) = \frac{\text{Power density in one sideband per Hz bandwidth at an offset frequency f away from the carrier}}{\text{Total signal power}}$$

For small phase fluctuations, we can write

$$S_C(f) = \left(\frac{\beta}{2}\right)^2$$

Here, β is the modulation index by analogy to modulation theory.

$$S_C(f) = \left(\frac{\Delta f_{peak}}{2f}\right)^2$$

$$= \frac{(\Delta f_{rms})^2}{2f^2}$$

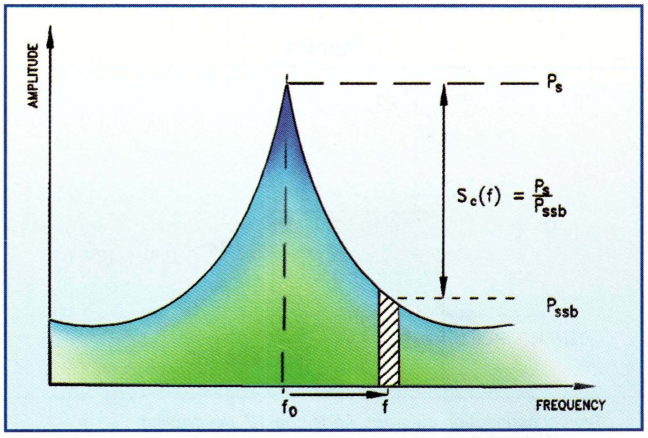
$$S_C(f) = 1/2\,(S_{\Delta\theta}(f))$$

$S_C(f)$ is often expressed in decibels relative to the carrier per Hz (dBc/Hz) and is related to the power spectrum observed on a spectrum analyzer. The National Bureau of Standards defines Single Side Band Phase Noise as the ratio of power in one phase modulation sideband per Hertz bandwidth, at an offset f Hertz away from the carrier, to the total signal power. Here, f is the offset frequency from the carrier.

$$S_C(f) = \frac{P_s}{P_{ssb}}$$

where P_s is the carrier power and P_{ssb} is the sideband power in one Hz bandwidth at an offset frequency of f from the center. This is illustrated in Figure 3.

Figure 3



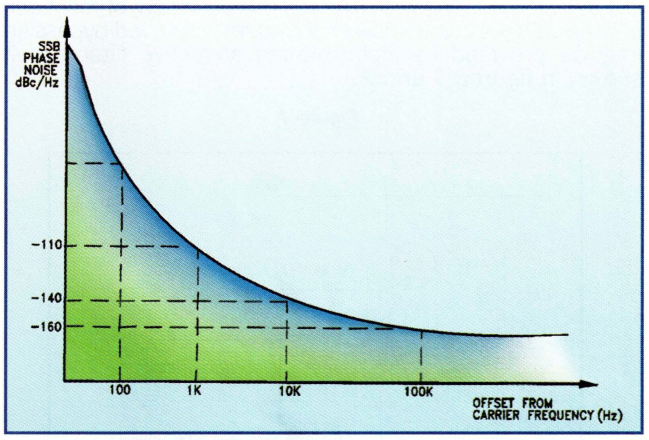
Single sideband phase noise to carrier ratio

The Single Sideband Phase Noise is usually given logarithmically, that is:

$$S_C(f) \text{ in dB} = 10 \times \log[S_C(f)]$$

This is shown in Figure 4 as a spectral density plot of the phase modulation sidebands in the frequency domain. It is expressed in dB relative to the carrier per Hz bandwidth.

Figure 4



Single sideband phase noise representation

The phase noise generated by a VCO is determined by:

(a) Q factor of the resonator.
(b) Q of the varactor diode.
(c) the active device used for the oscillating transistor.
(d) power supply noise.
(e) external tuning voltage supply noise.

The noise contribution made by (d) and (e) can be minimized by careful choice of the power supplies (see Application Note 3). The phase noise of the VCO is therefore determined primarily by the overall Q of the circuit. In order to design a circuit with high Q, the tuning bandwidth must be made small. Therefore a VCO designed for low phase noise performance will have a smaller tuning range.

WAYS TO MINIMIZE NOISE

The following steps are recommended for obtaining the best overall performance from Mini-Circuits VCOs.

1. Power Supply (V_{cc}) and tuning voltage (V_{tune}) returns must be connected to the printed circuit board ground plane. VCO ground plane must be the same as that of the printed circuit board and therefore all VCO ground pins must be soldered direct to the printed circuit board ground plane.

2. Adequate RF grounding is required. Several chip decoupling capacitors must be provided between the V_{cc} supply and ground.

3. Good, low noise power supplies must be used. Ideally, DC batteries for both supply (V_{cc}) and tuning (V_{tune}) voltages will provide the best overall performance.

4. Output must be correctly terminated with a good load impedance. It is also a good practice to use a resistive pad between the VCO and the external load.

5. Connections to the tuning port must be as short as possible and must be well screened, shielded, and decoupled to prevent the VCO from being modulated by external noise sources. A low noise power supply must be used for tuning voltage (V_{tune}) supply.

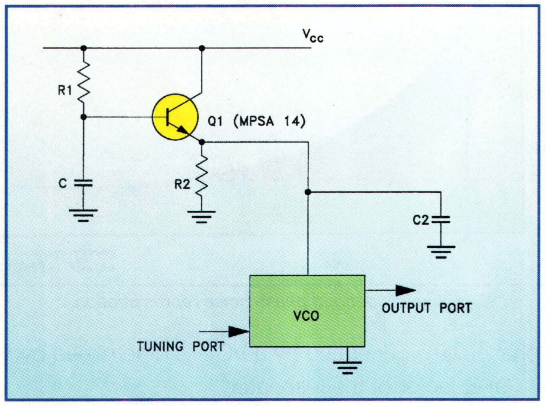
Reducing Power Supply Noise In VCOs

Technical Note 3

PRACTICAL TECHNIQUES

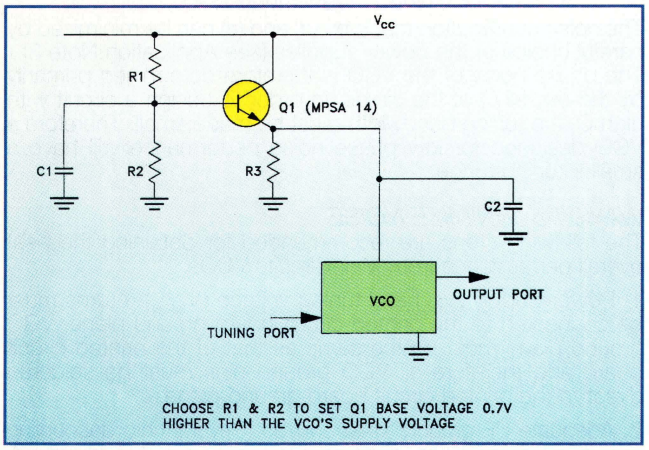
It is always a good design philosophy to provide RF bypassing of power and dc control lines to the VCO. This is indeed the case when the VCO is located some distance away from the power supply. RF chokes and good bypassing capacitors of approximately 1000 pf to 0.1 µF is recommended at the DC supply lines. This will minimize the possibility of feedback between stages in a complex subsystem. Improved bypassing may be provided by incorporating an active filter circuit shown in figures 1 and 2.

Figure 1



Active bias circuit for improved power line filtering

Figure 2



Active bias circuit for providing more flexibility in setting V_{CC} for a given VCO

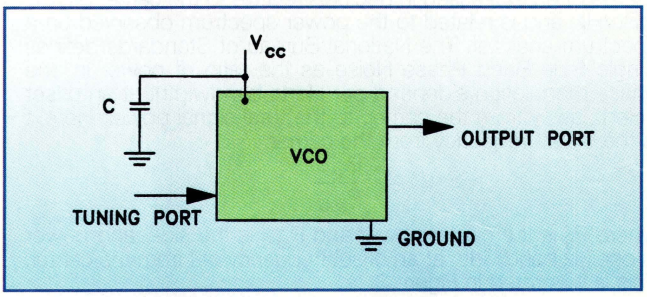
This type of RF bypassing is recommended for applications requiring a high level of noise suppression for externally generated noise signals. In most cases, the performance of the circuit in Figure 1, which is current biased, will be adequate and will have the advantage of better low frequency bypassing performance for a given value of base capacitor, fewer components, and lower power consumption.

It is only necessary to use the circuit in Figure 2 when the higher isolation offered by a larger V_{CC} is required. The circuit in Figure 2 is voltage biased. In this case, the circuit in Figure 2 offers a more stable operating point.

Noisy power supplies may cause additional noise. Power supply induced noise may be seen at offsets from 20Hz to 1MHz from the carrier. If the VCO is powered from a regulated power supply, the regulator noise will increase depending upon the external load current drawn from the regulator. The phase noise performance of the VCO may degrade depending upon the type of regulator used, and also upon the load current drawn from the regulator. To improve the phase noise performance of the VCO under external load conditions, one or more of the following steps may be taken:

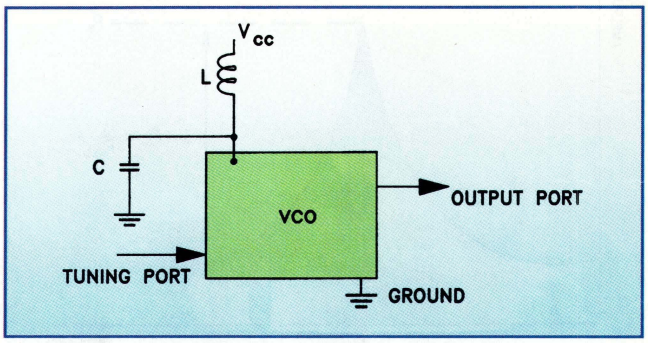
1. Place a low ESR electrolytic capacitor of about 10 µF on the V_{CC} line (See Figure 3).
2. In addition to the 10 µF capacitor mentioned in number 1 above, the decoupling of the V_{CC} line can be enhanced further by including a choke about 10 µH in series with the V_{CC} (See Figure 4).
3. Provide an active bypassing as shown in Figure 1 or 2.

Figure 3



Typical connection diagram. Power supply decoupling provides improved noise.

Figure 4



Typical connection diagram. Additional RF decoupling provided by LC type filter improves power line filtering.

Technical Note 4

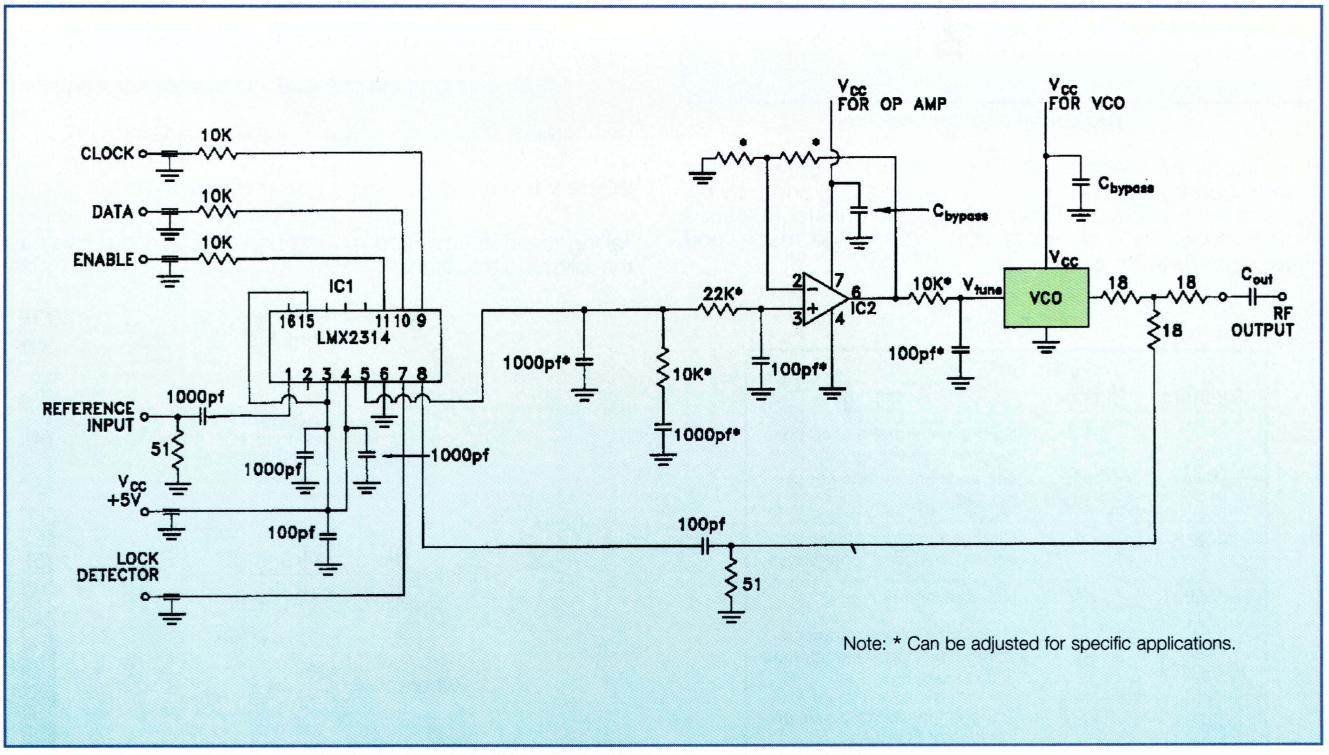
The following section describes the design features of a synthesizer using Mini-Circuits VCOs together with an integrated serial synthesizer and a passive loop filter. It is ideal for use in portable applications where high performance, low power consumption, and small size is required.

The design example covered here is an 800 to 900MHz synthesizer in 100kHz steps with a minimum output power of 10mW across the band. Mini-Circuits model POS-1060, a low noise voltage controlled oscillator that operates over the range of 750 to 1060MHz, is used. Frequency synthesis is by using National Semiconductor™ integrated circuit type LMX2314. Any similar integrated synthesizer chip may also be used. Figure 1 shows a block diagram of the synthesizer. A sample of the VCO output drives a divide by 64 prescalar which in turn drives a programmable counter. The output of the programmable counter drives the phase detector. The reference signal to the phase detector is obtained by dividing the reference signal by R. The reference signal is provided by an external 5MHz crystal oscillator. The output of the phase detector is a series of pulses corresponding to the frequency difference between the VCO and the reference.

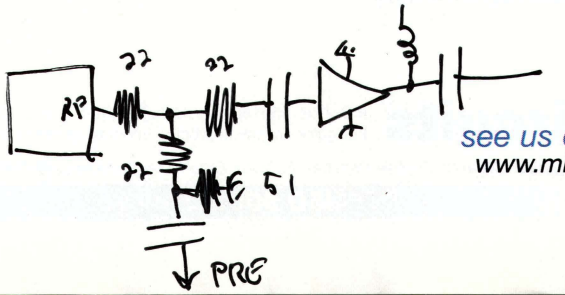
The current pulses are filtered, amplified, and applied to the VCO control port to reduce the phase error, and therefore to achieve a phase lock. When there is a phase error between the reference and the VCO, the dc error signal from the phase detector is amplified, filtered, and applied to the control port of the VCO until the phase error reduces to zero.

The IC2 shown is a high input impedance operational amplifier that interfaces with any VCO whether wide band or narrow band. It is, however, optional and may be omitted if a narrow band VCO is used. Here, the tuning range needed for frequency coverage is less than the supply voltage used for the synthesizer circuit. For example, when the LMX2324 is operated with a +5V supply, the available tuning range for the VCO is less than 5V without the operational amplifier. The tuning range may be increased with the use of an operational amplifier, as shown. Mini-Circuits offers a wide variety of voltage controlled oscillators, including 5V units, that can be used for synthesizer applications. For special requirements, customers may complete the VCO "Parameter Specification Check List" (see page 114), and mail or fax it to Mini-Circuits applications department for a fast, courteous, and knowledgeable response.

Figure 1



Detailed schematic of the synthesizer discussed



Phase Locked Loop Fundamentals Technical Note 5

The basic form of a phase locked loop (PLL) consists of a voltage controlled oscillator (VCO), a phase detector (PD), and a filter. In its more general form (Figure 1), the PLL may also contain a mixer and a digital divider. In the steady state, the frequency of the VCO is given by the expression:

$$f_o = f_m \pm Nf_r \quad \text{.....(1)}$$

where: f_m is a mixing frequency
f_r is a reference frequency

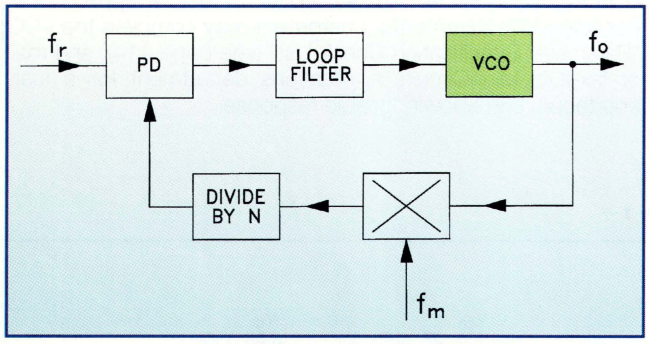
The frequency of the VCO may be controlled by several methods, including the following:

(i) By varying N with both f_r and f_m constant.

(ii) By varying f_m and N with f_r constant.

(iii) By varying f_m and f_r with N constant.

Figure 1



Basic form of phase lock loop

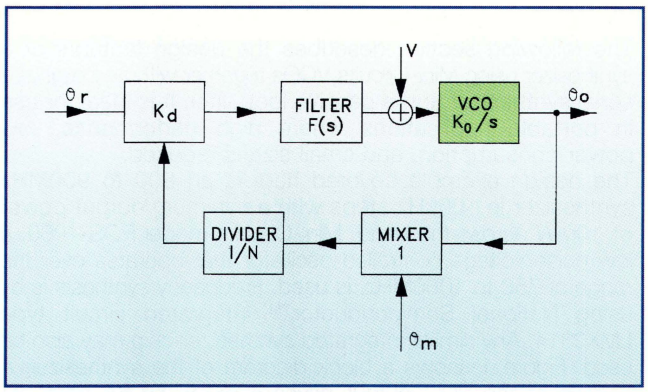
It is helpful to consider the PLL in terms of phase rather than frequency. This is done by replacing f_o, f_m, and f_r by θ_o, θ_m, and θ_r respectively. Table 1 shows the transfer functions of the various loop elements with this change made, and Figure 2 shows the circuit.

Table 1

Element	Transfer Function	Remarks
VCO	K_o/s	K_o the slope of the oscillator frequency to voltage characteristic in rads per sec. per volt.
MIXER	1	Change of output phase equals change of input phase.
DIVIDER	N/1	N is division ratio
PHASE DETECTOR	K_d	K_d is slope of phase detector voltage to phase characteristic in volts/radians.
FILTER	F(s)	Transfer function depends on the type of filter used.

Transfer functions of phase locked loop components

Figure 2



Equivalent circuit of PLL

The transfer function, H(s), of a single feedback loop shown in Figure 2 is given by:

$$H(s) = \frac{\text{Forward Gain}}{1 + \text{Open Loop Gain}} \quad \text{.....(2)}$$

The phase of the VCO can be controlled as follows:

(i) By changing the phase, θ_m of the mixing frequency.

(ii) By changing the phase, θ_r of the reference frequency.

(iii) By changing voltage V at the modulation port.

Where V is the voltage input at the modulation port.

Taking these in turn, and making use of equation 2, we have the following equations:

$$H_1(s) = \frac{\theta_o}{V} = \frac{K_o}{s+K\,F(s)} \quad \text{.....(3)}$$

$$H_2(s) = \frac{\theta_o}{\theta_m} = \frac{KF(s)}{s+KF(s)} \quad \text{.....(4)}$$

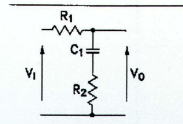
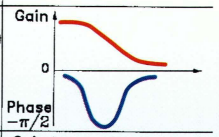
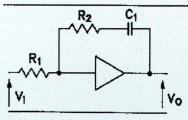
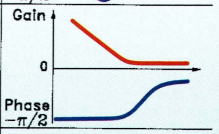
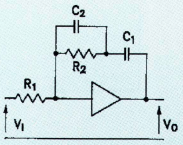
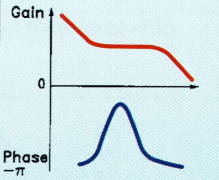
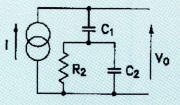
$$H_3(s) = \frac{\theta_o}{\theta_r} = \frac{NKF(s)}{s+KF(s)} \quad \text{.....(5)}$$

$$\text{where } K = \frac{K_d K_o}{N}$$

and s is a complex variable used in Laplace transform and is equal to $j\omega$.

The role of the loop filter F(s) is to filter spur signal at Fr or the comparison frequency. (As a rule of thumb, its F_{cutoff} should be 1/10 of Fr. The filter is made of resistors and capacitors. If resistors values are multiplied by a constant, while capacitors values are divided by the same constant, then F(s) is not changed. Since the resistors thermal noise affects the phase noise, it is recommended that the Loop Filter be built from low resistance values.

Table 2

Element	Type	Transfer function	Time constants	
	lag/lead	$\frac{1+sT_2}{1+sT_1}$	$T_1 = C_1(R_1 + R_2)$ $T_2 = C_1R_2$	
	Integrator & lead	$\frac{1+sT_2}{sT_1}$	$T_1 = C_1R_1$ $T_2 = C_1R_2$	
	Integrator & lead/lag (phase comparator gives a voltage output)	$\frac{1}{sT_1}\ \frac{1+sT_2}{1+sT_3}$	$T_1 = C_1R_1$ $T_2 = R_2(C_1 + C_2)$	
	integrator & lead/lag (phase comparator gives a current output)	$\frac{1}{sC_1}\ \frac{1+sT_2}{1+sT_3}$	$T_3 = C_2R_2$	

Transfer functions and bode diagram of various filter networks

The loop filter F(s) may take one of the following forms:

(i) A lag/lead network

(ii) An integrator combined with a lead network

(iii) An integrator combined with a lead/lag network

These three forms, together with their transfer functions and Bode Diagrams, are summarized in Table 2.

From Figure 2, it can be seen that the open loop gain is given by:

$$G_{OL}(s) = \frac{KF(s)}{s} \qquad \text{.....(6)}$$

The open loop gains for the three filters shown in Table 2 are as follows:

(i) Lag/Lead filter

$$G_{OL}(s) = \frac{K(1+sT_2)}{s(1+sT_1)} \qquad \text{.....(7)}$$

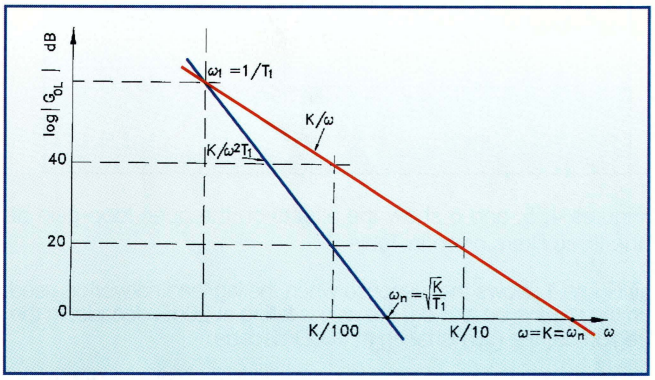
(ii) Integrator plus lead

$$G_{OL}(s) = \frac{K}{s^2T_1}(1+sT_2) \qquad \text{.....(8)}$$

(iii) Integrator plus lead/lag (voltage type phase detector).

$$G_{OL}(s) = \frac{K(1+sT_2)}{s^2T_1(1+sT_3)} \qquad \text{.....(9)}$$

Figure 3



Gain VS. frequency graphs of K/ω and K/ω^2T_1

The terms K/s (equation 7) and K/s^2T_1 (equations 8 and 9) may be expressed, in the frequency plane, by gain lines having slopes of -20dB/decade and -40dB/decade respectively, as shown in Figure 3.

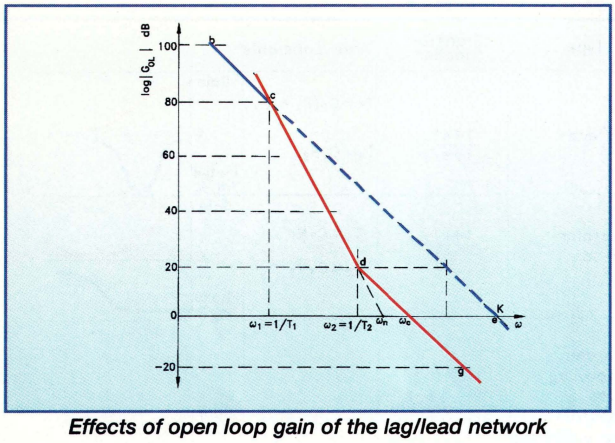
Three very important points should be observed from the graphs:

(i) The K/ω graph has unity gain at ω=K

(ii) The K/ ω^2T_1 graph has unity gain at $\omega = \sqrt{K/T_1}$, and

(iii) The two graphs meet at $\omega_1 = \frac{1}{T_1}$

Figure 4



Effects of open loop gain of the lag/lead network

Figure 5

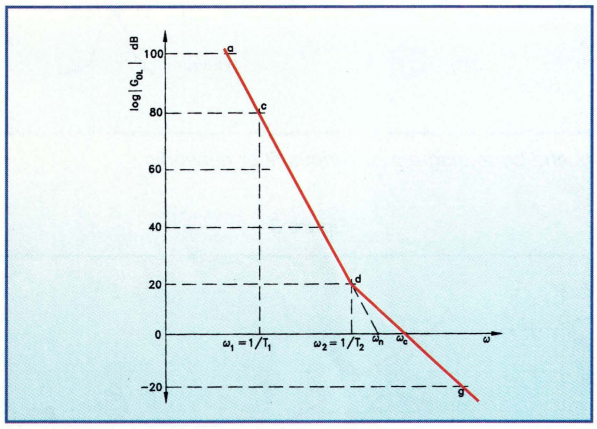


Figure 6

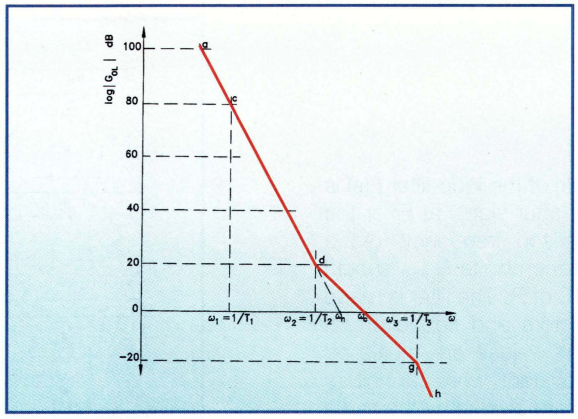
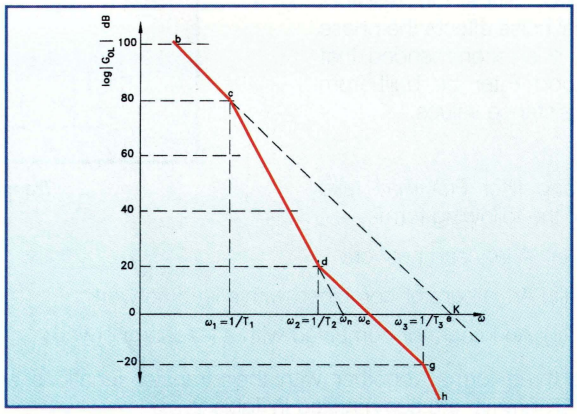


Figure 7



Effects of open loop gain of the integrator and lead/lag network with a current type phase detector

Figures 4, 5, and 6 show the effects on the open loop gain of the three filters given in Table 2.

(i) Figure 4 shows the response when the lag/lead network is used. In the regions bc and dg, the gain is falling at 20dB/decade. In the region cd, the gain is falling at 40dB/decade.

(ii) Figure 5 shows the response when the integrator plus lead network is used. In the region acd, the gain is falling at 40dB/decade.

(iii) Figure 6 shows the response when the integrator plus lead/lag network is used. In the region gh, the gain is falling at 40dB/decade. In the region dg, the gain is falling at 20dB/decade. From the foregoing, it is clear that:

$$\omega_n^2 = \frac{K}{T_1} \qquad \text{.....(10)}$$

$$\omega_n^2 = \frac{\omega_C}{T_2} \qquad \text{.....(11)}$$

$$\omega_c = \frac{KT_2}{T_1} \qquad \text{.....(12)}$$

(For voltage type phase detector)

The choice of the phase detector is determined primarily by the application. For receiver applications where low noise signal levels are encountered, double balanced mixers are used as phase detectors. For synthesizer applications, a digital type phase detector is preferred. This type of phase detector produces a current output. The transfer function, K_d, has units of amps/rad. The line bcdgh in Figure 7 represents the response for this phase detector/filter combination.

If the phase detector is not ideal but has a leakage resistance R_L, then it can be shown that $T_1=R_1C_1$ and the open loop unity gain frequency (point e on Figure 7) is given by $K^1 = KR_L$. For an ideal phase detector there will be no leakage, and hence $\omega_1 \rightarrow 0$ and $K^1 \rightarrow \infty$.

From the foregoing it should be clear that both ω_c and ω_n can be redefined in terms of C_1:

$$\omega_n^2 = \frac{K}{C_1} \qquad \text{.....(10a)}$$

$$\omega_n^2 = \frac{\omega_C}{T_2} \qquad \text{.....(11)}$$

$$\omega_c = \frac{KT_2}{C_1} \qquad \text{.....(12a)}$$

One effect of adding a filter is to reduce the open loop unity gain frequency from K(or K^1) to ω_C. Frequencies below ω_C will be called *in-band* and frequencies higher than ω_C will be called *out-of-band*. The phase locked loop uses its *in-band* gain to enable the VCO to follow that of the reference frequency, and uses its *out-of-band* attenuation to reject unwanted phase components that may be present on the reference signal. Consequently, in most applications, the response bcdgh, given by the integrator plus lead/lag network, is preferred.

A brief analysis of the phase noise performance of the PLL is given here. The noise model is presented in Figure 8 along with the equations 14 through 17.

Equation 17 describes the noise output of the PLL given the noise contribution of the reference source, the phase detector, the loop filter, the VCO, and the feedback divider. The closed loop transfer function of the loop can be shown to be given by:

$$H(s) = \frac{\text{Forward gain}}{1+\text{Loop Gain}}$$

The loop gain G is the product of all the transfer functions, i.e.:

$$G = \frac{K_o K_d F(s)}{Ns}$$

$$= \frac{K F(s)}{s} \qquad \text{.....(13)}$$

$$\text{Where } K = \frac{K_o K_d}{N}$$

For type 2 phase locked loop, the filter consists of an integrator combined either with a lead network or with a lead/lag network.

The reference noise and the divider output noise contribution calculations follow.

The closed loop transfer function from point 1 to 4 in Figure 8 relating oscillator phase θ_{out} to reference θ_r can be shown to be given by:

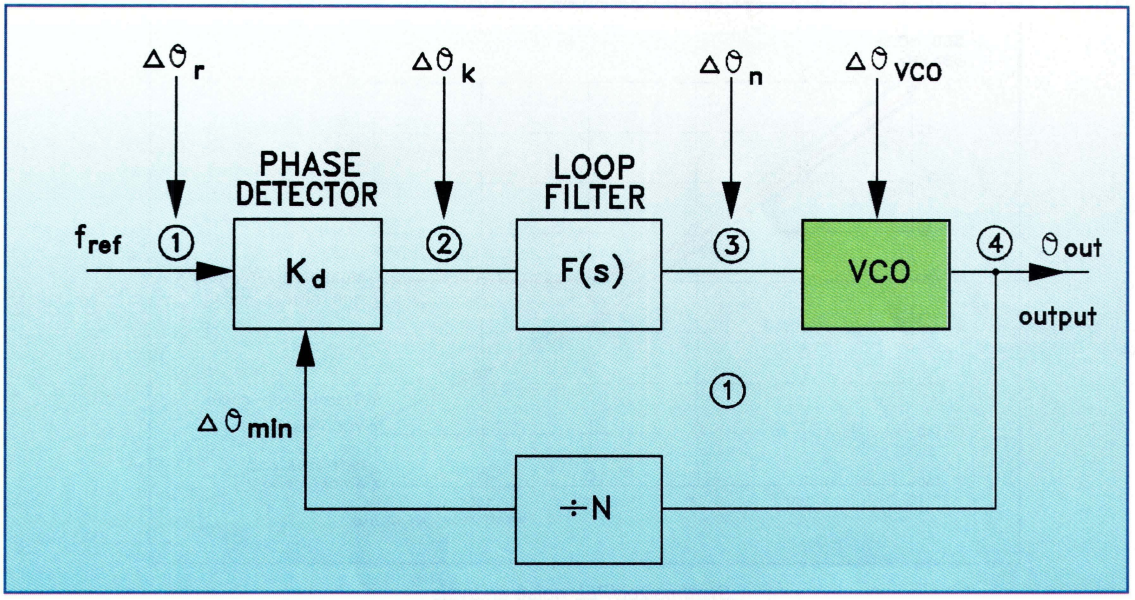
$$\frac{\theta_{out}(s)}{\theta_r(s)} = \frac{N K F(s)}{s + K F(s)}$$

The phase noise contributions of reference and divider noise are therefore given by:

$$\Delta\theta_{out}^2 = \left[\frac{N}{1 + \frac{s}{K F(s)}}\right]^2 \left[\Delta\theta_{ref}^2 + \Delta\theta_{div}^2\right] = x^2 \qquad \text{.....(14)}$$

The loop division ratio must therefore be minimized so as to minimize the divider noise contributions.

Figure 8



Phase locked loop noise model

The phase detector also contributes to the output noise. In general, any noise input following the phase detector contributes to the output noise. With reference to Figure 8, the transfer function from point 2 to 4 is:

$$\frac{\Delta\theta_{out}(s)}{\Delta\theta_K(s)} = \frac{\frac{F(s)\ K_o}{s}}{1 + \frac{K_d K_o F(s)}{SN}}$$

$$= \frac{1}{K_d} \bullet \frac{N}{1 + \frac{s}{KF(s)}}$$

Any noise input following the phase detector is therefore inversely proportional to K_d. The noise contribution is then given by:

$$\Delta\theta^2_{out} = \frac{1}{K_d^2}\left[\frac{N}{1 + \frac{s}{K\,F(s)}}\right]^2 \Delta\theta_K^2 = Y^2 \qquad \text{.....(15)}$$

The phase detector gain constant must therefore be maximized so as to minimize the accompanying noise contributions. Outside the loop bandwidth, the noise will be mainly a function of the VCO. With reference to Figure 8, the transfer function from point 3 to 4 is given by:

$$\frac{\Delta\theta_{out}}{\Delta\theta_{VCO}} = \frac{1}{1 + \frac{K\,F(s)}{s}}$$

When evaluating the output noise spectrum we must take into account the VCO noise and also its sensitivity. The following equation gives all the VCO noise contributions:

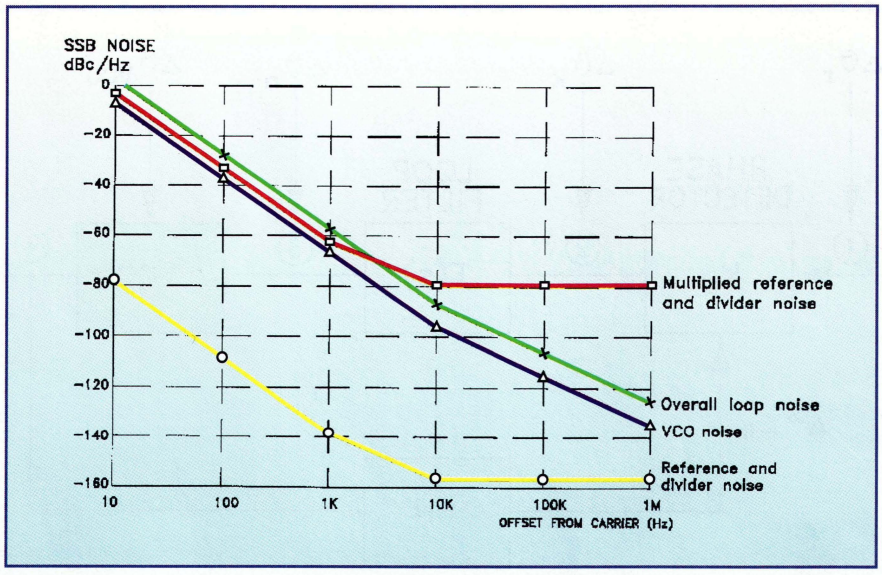
$$\Delta\theta^2_{out} = \left[\frac{s}{s + K\,F(s)}\right]^2 \left[\Delta\theta^2_{VCO} + \frac{K_o^2}{s^2}(\Delta\theta_n)^2\right] = Z^2 \qquad \text{.....(16)}$$

Here K_o is the VCO gain constant and $\Delta\theta_n$ is any noise voltage appearing before the VCO.
The overall phase noise of the the synthesizer may be written as

$$\Delta\theta^2_{out} = X^2 + Y^2 + Z^2 \qquad \text{.....(17)}$$

The phase noise combination of the reference oscillator, dividers, and the VCO, are shown plotted in Figure 9.
In conclusion, within the loop bandwidth the reference noise will be multiplied by the loop division ratio. Outside the loop bandwidth the reference noise will be attenuated by the loop transfer function. Within the loop bandwidth, the VCO noise will be attenuated. Outside the loop bandwidth, the noise will be the same as that of the free running VCO.

Figure 9



Synthesizer/PLL noise analysis

5. Design Considerations of PLL Synthesizer Loop Filter

1. Application.
1.1. A common application of a VCO is its incorporation in a Phase Locked Loop (PLL) Frequency Synthesizer.
1.2. A block diagram of a PLL is shown in Fig. 10.
1.3. In this application, a low-pass filter ("Loop Filter") is introduced in order to suppress spurious oscillations of the reference oscillator in proximity of the output frequency. Special attention should be paid to the design of the loop filter in order to minimize a deterioration of Phase Noise in the output.
1.4. As the cut-off frequency of the loop filter is rather low, it is usually realized using resistors and capacitors.
1.5. The purpose of this paper is to analyze the circuit noise and suggest design criteria for the loop filter in order to minimize it.

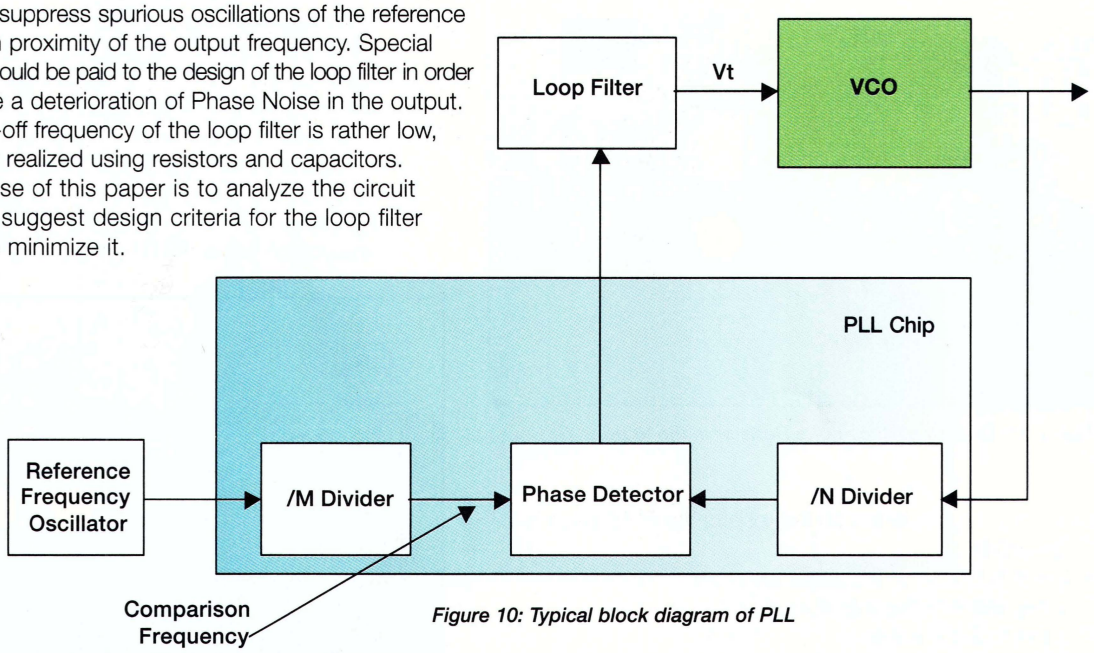


Figure 10: Typical block diagram of PLL

2. Fig. 11 shows two typical examples of the low-pass loop filter.
2.1. As a rule of thumb, the cut-off frequency of the low-pass loop filter is chosen as Fco ≤ fcomp/10 (fcomp being the comparison frequency).
2.2. As a second rule of thumb, the resistor should be chosen as small as possible, but not above 1 Kohm, and the capacitor value should be chosen as large as possible, limited by the available space.
2.3. It should be noted that proper filter design may improve the Phase Noise by 10-25 dB, depending on the frequency offset.
2.4. The designer faces two contradicting requirements:
2.4.1. He needs a narrow band loop filter in order to suppress the spurious oscillations of the comparison frequency, as reflected in the output of the synthesizer.
2.4.2. On the other hand, this narrow band loop filter increases the Phase Noise of the synthesizer and its settling time.
2.5. The analysis of the Phase Noise performance shows that the Phase Noise depends on the resistor value. The higher the resistor, the higher is its contribution to the Phase Noise. The analysis shows also that the Fco of the filter is a function of τÔ=RC.

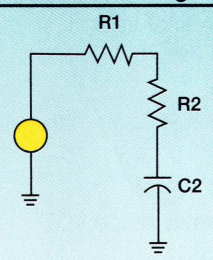
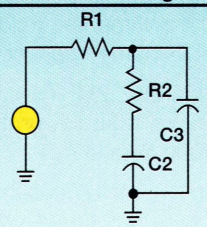
Passive Lead-Lag	Passive Lead Lag with Pole
	
$F(s)=\frac{s\tau_2+1}{[s(\tau_1+\tau_2)+1]}$ $\tau_1 = R_1C_2;\ \tau_2 = R_2C_2$	$F(s)=\frac{s\tau_2+1}{[s(\tau_1+\tau_2)+1](s\tau_3+1)}$ $\tau_1 = R_1C_2;\ \tau_2 = R_2C_2;$ $\tau_3 = (R_2 \| R_1)C_3$
Type 1.5, 2nd Order (Low Gain)	Type 1.5, 3rd Order (Low Gain)

Figure 11: Typical Loop Filters.

3. Noise Calculations

3.1. A practical resistor in the Vt port of the VCO can be substituted by an ideal resistor and an equivalent noise source. The value of the source is $\overline{U^2}$. See Fig 12.

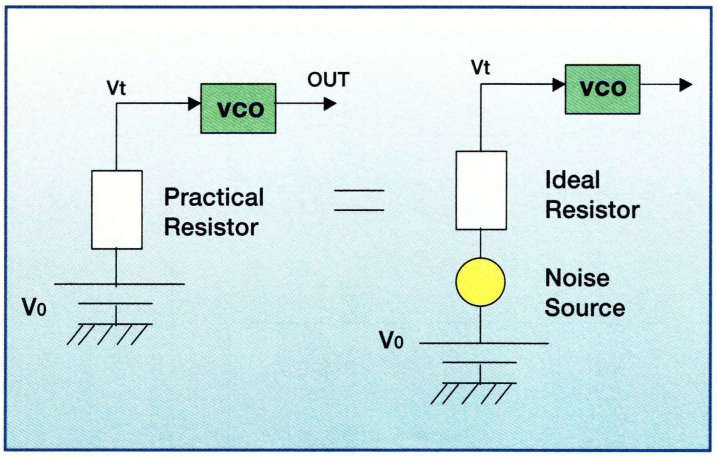


Figure 12: Equivalent Circuit of a Resistor in the Vt port.

3.2. A noise voltage u(t) develops on the resistor. Its RMS value is

(1) $\overline{U^2}= 4KTR$

where K is Boltzman's Constant,
T is the absolute temperature,
R is the resistor value.

3.3. This voltage is applied to the varactor, thus changing its capacitance and modulating the VCO, creating frequency noise. The resulting Phase Noise is a function of this frequency noise.

3.4. The spectrum of the resistor noise is uniform, therefore the spectrum of the frequency noise is also uniform.

3.5. The RMS of the frequency noise $\overline{N_f^2}$ is

(2) $\overline{N_f^2}=\overline{Kv^2}*4KTR= \overline{Kv^2}\ \overline{U^2}$,

Figure 12: Equivalent Circuit of a Resistor in the Vt port.
If the frequency is

(3) $f(t) = f_0 + KvAcos(2\pi f_{mt})$,

where f_0 is the resulting frequency of the VCO when V_0 is applied to the Vt port.
Then, from (3), the phase is:

(4) $\phi(t)=2\pi\int f(t)dt=2\pi f_0 t+\frac{2\pi}{2\pi f_m} KvA\sin(2\pi f_{mt})=f_0(t)+\frac{KvA}{f_m}(2\pi f_{mt})$

3.6. This means that the Phase Noise at a point f_m away from the carrier frequency can be derived by dividing the frequency noise by f_m, or

(5a) $N_\varphi(t) = Nf(t) / f_m$

The Phase Noise behaves as

(5b) $\overline{N_f^2} = \frac{\overline{Kv^2}}{f_m^2}\overline{U^2}$

3.7. It is obvious that every resistor in the loop filter contributes to the a/m phase noise. Fig. 11 shows the frequency response of the filters. It can be seen that it depends on τ=RC, the time constant of the circuit.

3.8. If one desires to calculate the noise contribution of the resistor at a frequency f_m away from the carrier frequency, the circuit has to be analyzed by replacing each resistor by an ideal resistor and an equivalent noise source U(t)= 4KTR. See, for example, Fig. 13.

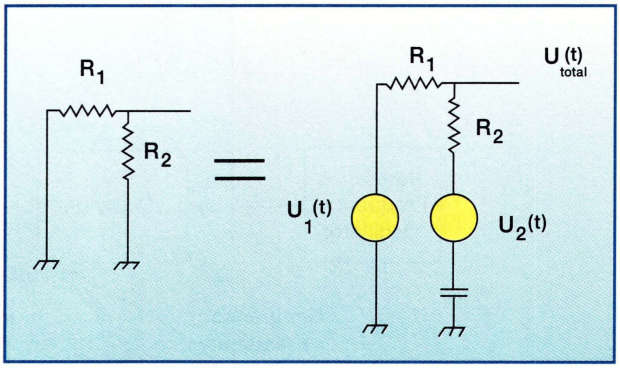


Figure 13: Noise source equivalent Circuits

(6) $U(t)_{total}= U_1(t)\ \frac{R_1+jXc}{R_1+R_2+jXc}+U_2(t)\frac{R_1}{R_1+R_2+jXc}$

(7) $\overline{U^2_{total}}= \overline{U_1^2}\ \frac{R_1^2+Xc^2}{(R_1+R_2)^2+Xc^2}+\overline{U_2^2}\frac{R_1^2}{(R_1+R_2)^2}$

$\overline{U_1^2}=4KTR_1$

$\overline{U_2^2}=4KTR_2$

4. The Phase Noise at a frequency f_m away from the carrier will then be

$\overline{N_\varphi^2}_{total} = \frac{\overline{Kv^2}}{f_m^2}\overline{U_{total}^2}$

5. It can be seen that the noise power density is inversely proportional to the square of Fm, which means that it drops at 20dB/decade.

1. HOW TO MEASURE OUTPUT POWER AND FREQUENCY

Figure 1 is a block diagram of the setup for this measurement. Well regulated power supplies are recommended for tuning and V_{CC} supplies. Bias Tee's in the DC and tuning voltage lines help reduce the power supply noise. The VCO output A is divided into two signals B and C. The signals B and C are connected to the spectrum analyzer D and power meter E respectively. Modern spectrum analyzers, such as HP8563E have sufficient accuracy for measuring frequency, and this spectrum analyzer is used for frequency measurement. The span and resolution bandwidth is set appropriately for the measurement. The system is calibrated by measuring the insertion loss of the RF path from A to E as a function of frequency. These insertion loss measurements are used to compute the actual output power of the VCO. The VCO frequency is changed by changing the tuning voltage. For different tune voltages the VCO output power is read from the power meter. The frequency is read from the spectrum analyzer using peak search function. A computer attached to the system can be used to automate the measurements.

2. HOW TO MEASURE TUNING SENSITIVITY AND LINEARITY

Tuning sensitivity is defined as the frequency change per unit volt of tuning voltage. The setup shown in Figure 1 can also be used for this measurement. For different tune voltages, the VCO frequency is read from the spectrum analyzer. The frequency measurements are plotted against the tune voltage. The slope of this characteristic is the tune voltage sensitivity and can be calculated at different tune voltages. The data can also be used to calculate the linearity as defined in Application Note 1. A simple program can automate this measurement.

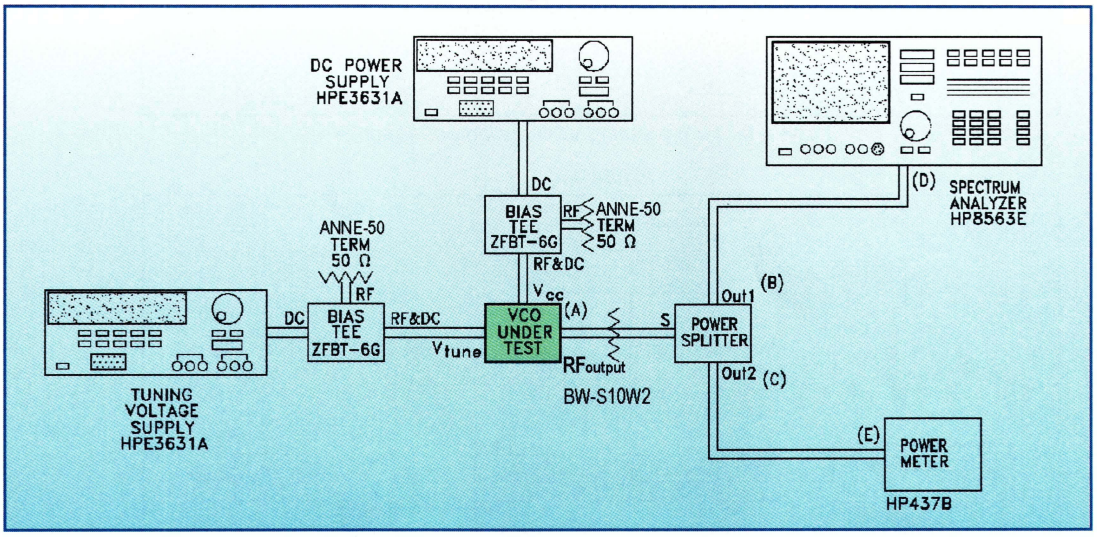
3. HOW TO MEASURE HARMONICS AND SPURIOUS LEVELS

VCOs are normally operated under high nonlinearity, and therefore generate harmonics. The setup shown in Figure 1 can also be used for this measurement. The harmonic level is measured relative to the fundamental signal level. A marker is placed on the fundamental signal and, using delta marker, the harmonic level is measured. For different tune voltages, the harmonic levels are measured relative to the fundamental signal. A simple program can also automate these measurements.

4. HOW TO MEASURE FREQUENCY PUSHING

Frequency pushing is caused by the VCOs sensitivity to supply voltages. Pushing is a measure of the sensitivity of the VCO output frequency to supply voltage and is expressed in MHz/volt. The setup shown in Figure 1 can also be used for this measurement. The supply voltage is set at its nominal setting and the VCO frequency is recorded for different tune voltages. Next, the supply voltage is increased by 1 volt and the VCO frequency is measured for different tune voltages as before. Lastly, the supply voltage is decreased by 1 volt from the nominal, and the frequency is measured for different tune voltages once more. At a given tuning voltage, the frequency change due to 1 volt supply voltage change gives the pushing. It may be different at different tuning voltages. A simple program can also automate these measurements.

Figure 1



VCO test set up

5. HOW TO MEASURE FREQUENCY PULLING

Frequency pulling is a measure of the frequency change due to a non-ideal load. It is measured by noting the frequency change caused by a load having a nominal XdB (usually X =12) return loss with all possible phases. Traditionally used low loss coupler may be avoided if monitoring signal is taken from V_{CC} bias tee. This reduces additional error because of the main line coupler loss. The RF leakage of the VCO to the V_{CC} port is enough to monitor the frequency. Figure 2 shows the setup for this measurement. Pulling may be different over the operating frequency band, and may need to be measured at several points in the operating bandwidth. The spectrum analyzer output frequency is set to the VCO output frequency. The measurements consist of the following steps:

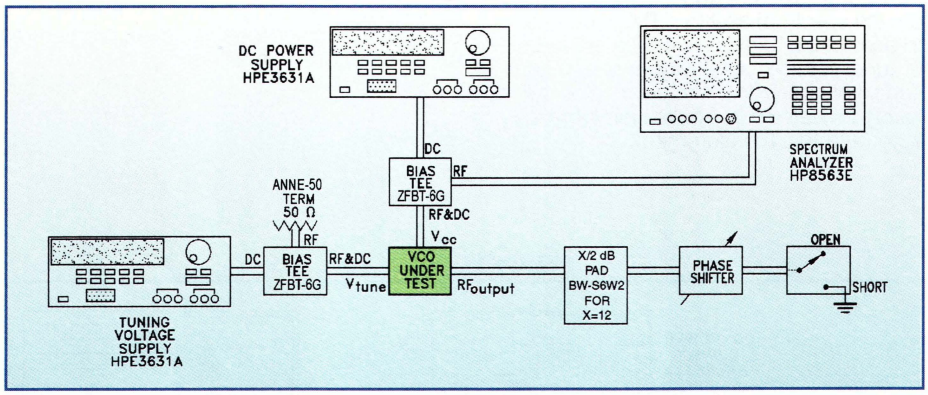
1. Tune phase shifter to get the maximum (or minimum) frequency with short on the end of the output line.
2. Use peak search and normalize marker to zero.
3. Change reflected phase by 180° by switching short to open.
4. Fine tune phase shifter to get to minimum (or max.).
5. Use peak search and read the frequency pulling value.

In a case where the VCO output frequency is too low, a continuously variable phase shifter cannot be obtained.

6. HOW TO MEASURE MODULATION BANDWIDTH

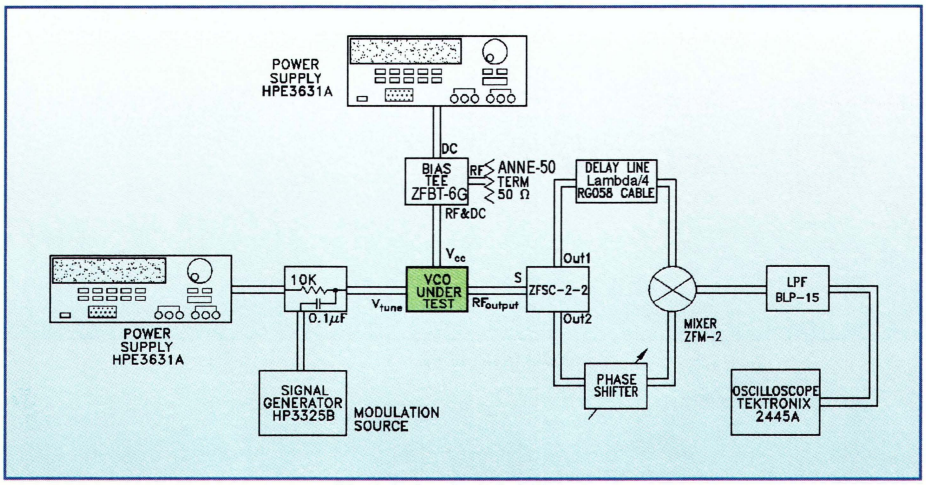
Modulation bandwidth is a measure of tuning port frequency response. It is measured using the setup shown in Figure 3(a). The principle of measurement is by modulating the VCO with a sine wave, then using a demodulator to demodulate the original modulating signal. If the frequency response of the demodulator is broad enough, this technique is good for characterizing the frequency response of the frequency response of the modulation port. The discriminator is obtained by using standard Mini-Circuits parts as shown in the Figure. The VCO output is divided into two parts using a power splitter. The mixer ZFM-2 acts as a phase detector and demodulates the FM modulated signal. The output signal is applied to an oscilloscope through a low-pass filter (BLP-15). The frequency of the modulating signal, keeping the amplitude constant, is varied starting from a frequency very close to DC until the oscilloscope display drops by 3dB, or to 0.707 of its low frequency value. This frequency is recorded as the 3dB modulation bandwidth. In order to automate this measurement, a low frequency network analyzer can be used to replace the modulating source and the oscilloscope. Figure 3(b) shows this setup.

Figure 2



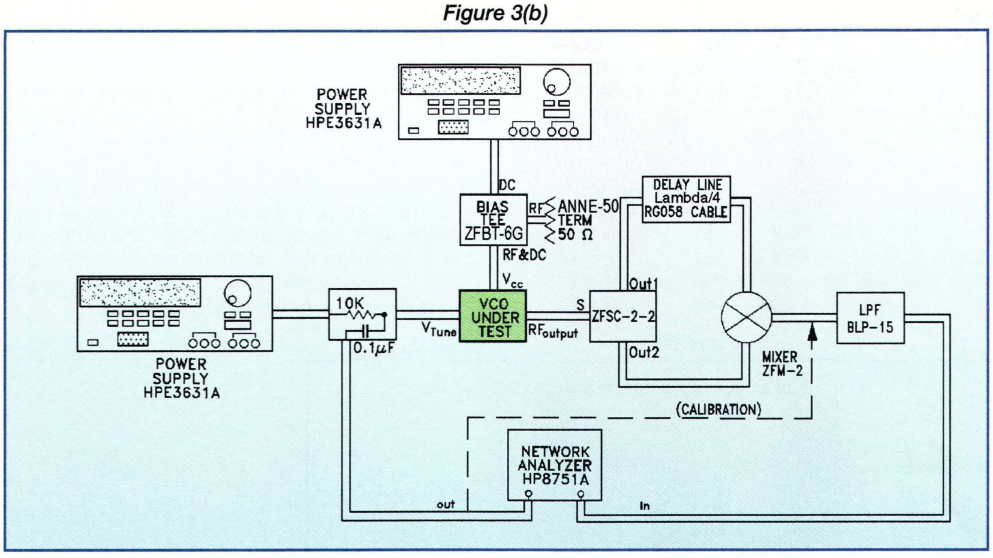
Test set up for measuring VCO pulling performance

Figure 3(a)



Modulation bandwidth set up

Figure 3(b)



Modulation bandwidth set up using network analyzer

7. MODERN METHOD OF VCO MEASUREMENT

Agilent has introduced a powerful VCO/PLL test system, the Agilent 4352B which is pictured in Figure 4(a). It has built-in low noise power supplies and is available for VCO testing. It measures VCO characteristics such as frequency, tuning sensitivity, output power, and harmonics as a function of tuning voltage. It can also be used to measure pushing, output power vs. V_{cc}, phase noise at a given offset vs. V_{tune} or V_{cc}, etc. The instrument is user friendly and does routine correction automatically. A set up using this instrument is illustrated in Figure 4(b).

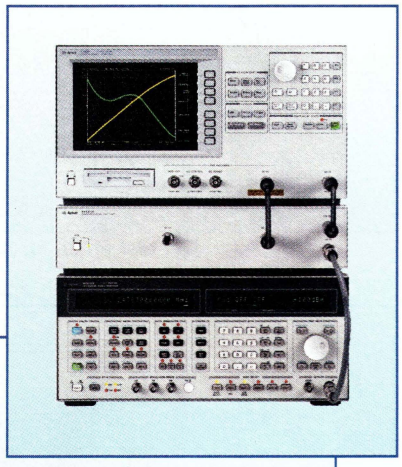


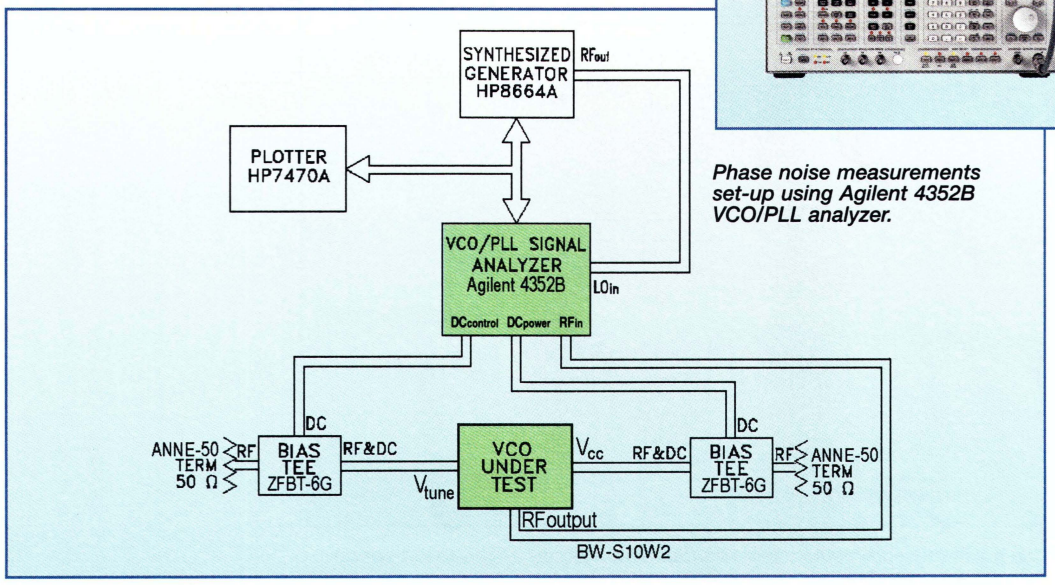
Photo courtesy

Agilent Technologies

Figure 4(a)

Phase noise measurements set-up using Agilent 4352B VCO/PLL analyzer.

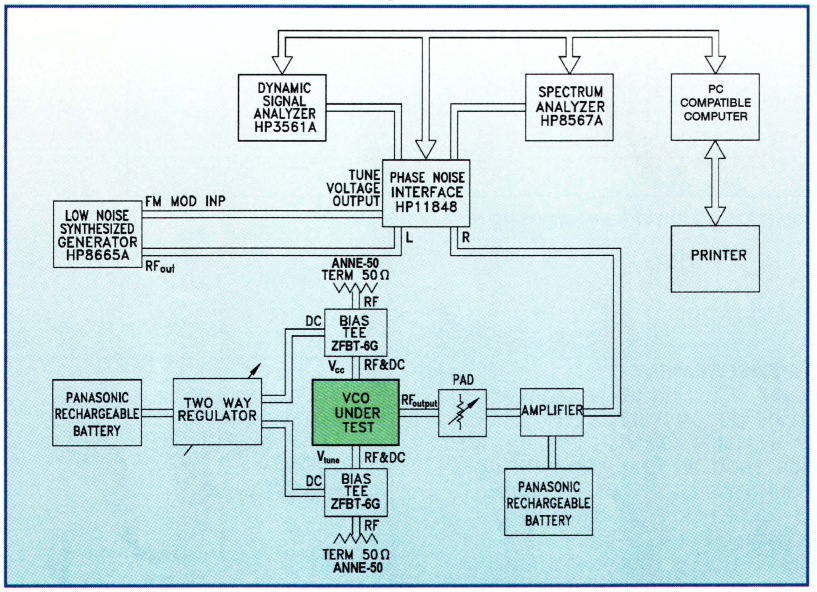
Figure 4(b)



8. HOW TO MEASURE PHASE NOISE

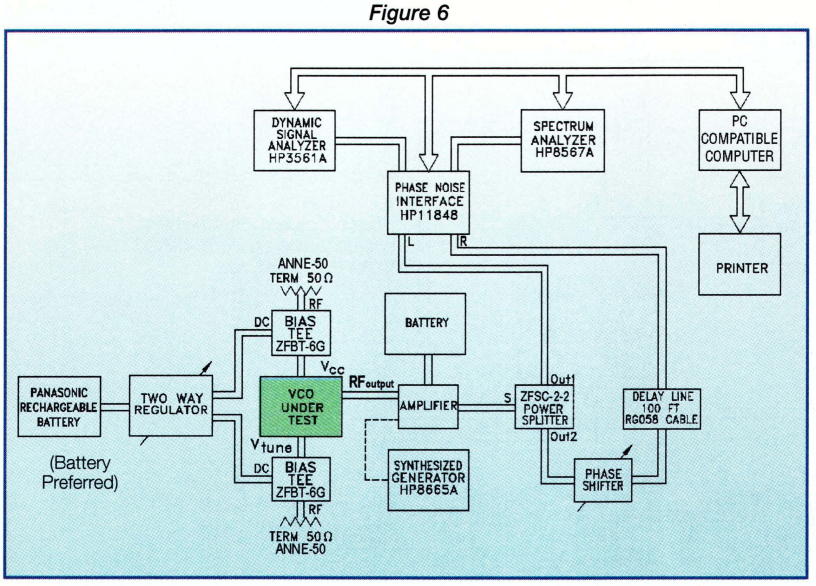
Phase noise represents the short term stability of the oscillator. Refer to Application Note 2 for details. The standard industry method of measuring phase noise is by the use of HP 3048A Phase Noise Analyzer. Depending upon the noise level, either PLL (Figure 5) or discriminator method (Figure 6) should be used. Batteries are used for V_{CC} and tuning voltage. This will minimize noise contribution of DC power supplies. Bias Tees (such as Mini-Circuits ZFBT-6GW) are recommended to get additional clean up of supply noise. In the PLL method, an external low noise reference oscillator is used. Noise floor of the external oscillator should be lower than the oscillator under test. Therefore, this method cannot be used for very low noise measurements, and the discriminator method should be used instead. The noise floor improvement is a result of elimination of external reference. This method is useful in measuring lower noise at higher offset frequencies. In general, noise measurements using HP 3048A are complex, and needs a qualified and trained operator. Luckily, new instruments such as HP4352S (from Agilent™), and NTS-1000A (from RDL™) simplifies the task. HP 4352S employs PLL method, and therefore has a limited noise floor. However, it still satisfies the requirement for a vast majority of applications. It is also useful in measuring other parameters of the VCO. NTS-1000A uses discriminator method, has a better noise floor, and is suited for low noise measurements.

Figure 5



General set up for phase noise measurement

Figure 6



Phase noise measurements using discriminator method of HP 3048A set up

Q. What type of VCOs are available from Mini-Circuits?

A. Mini-Circuits sells fundamental frequency oscillators up to 3GHz and beyond in surface mount (models JTOS and JCOS), plug in (model POS), and connectorized (model ZOS) versions.

Q. Generally, how do I select a VCO for a given application?

A. Narrow band VCOs generally have better phase noise than wide band VCOs. For example, Mini-Circuits narrow band model JCOS-1100LN exhibits a phase noise of -150dBc/Hz at 1MHz offset compared to -136dBc/Hz for the wider band model POS-1025 at the same offset frequency. Application wise, wide tuning VCOs are recommended for electronic counter measures such as radar, surveillance, etc., and narrow band VCOs are used in phase lock applications in receiver and transmitter systems.

Q. Can I use Mini-Circuits VCOs with a lower supply voltage?

A. Yes. Mini-Circuits VCOs can be operated with no damage at a lower voltage however, output power and tuning range may change. Mini-Circuits offers a variety of specialty oscillators designed for use with a lower supply voltage. Please consult factory with your specific requirements.

Q. Is there a delay from the time the supply voltage is applied to the VCO, and the time when the VCO actually starts to oscillate?

A. Yes, however the delay time is infinitesimally small. Mini-Circuits VCOs have a very fast response time to the supply voltage. For Mini-Circuits VCO model POS-535, the switching delay time is about 130 nS (typ.). Consult factory for further details.

Q. Do Mini-Circuits VCOs oscillate at 0 tuning voltage?

A. Yes. All Mini-Circuits VCOs are designed to work at a tuning voltage of 0 volts. Some oscillators may have lower output power at 0 tuning voltage.

Q. When the supply voltage to the VCO changes, what parameters are affected and how?

A. Both frequency and output power will change. Frequency change is characterized by pushing and is expressed in MHz per volt change. If the supply voltage is too low compared to the specified voltage, it may adversely affect the oscillation characteristics, and may even stop oscillating. If the supply voltage goes too high, power dissipation in the transistors will increase and will decrease the reliability of the unit.

Q. When the VCO is switched between two control voltages, how long does the VCO take to move from one frequency to another and settle?

A. Settling time is a function of the modulation bandwidth. Most Mini-Circuits VCOs exhibit a modulation bandwidth of greater than 90kHz unless otherwise specified. This corresponds to a settling time of the order of 0.01 millisecond.

Q. How does the VCO phase noise affect the overall noise of a Phase Locked Loop (PLL) system?

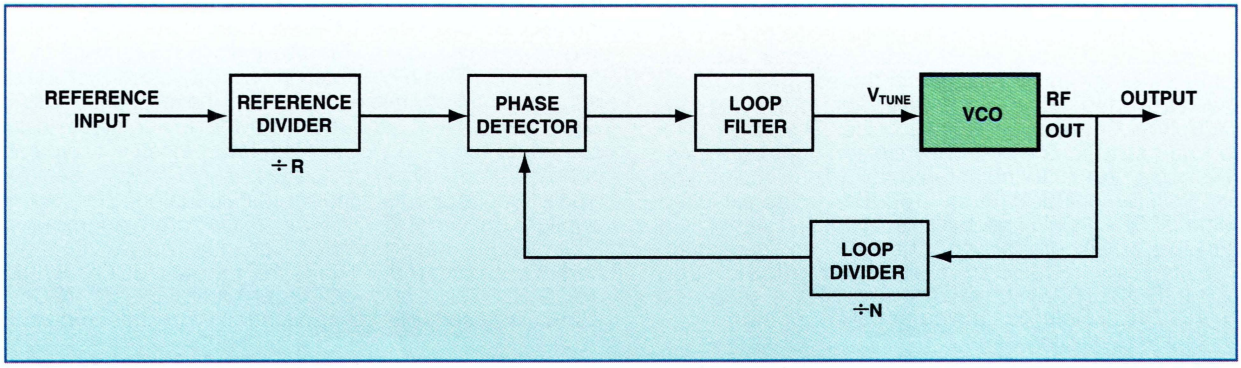
A. A conventional PLL is shown in Figure 1, and consists of a VCO phase locked to a stable frequency reference (refer to Technical Note 5, Phase Locked Loop fundamentals). The frequency of the signal coming from the stable external frequency reference oscillator (usually crystal oscillator) is divided by R, by the internal PLL frequency divider. The frequency of the VCO output signal is divided by N, by another internal PLL divider. Both divided signals are applied to the internal PLL phase detector. The low frequency products of the phase detector go through the loop filter and correct the frequency of the VCO. The loop filter is basically the low pass filter with the cutoff frequency of F_{cutoff}. The phase noise for the offsets above the value of F_{cutoff} would be essentially equal to the phase noise of the free running VCO. The phase noise for the offsets below the F_{cutoff} would be a sum of the phase noise of the phase detector noise increased by the 20LOG(N) plus the phase noise of the external reference (crystal) oscillator increased by the 20LOG(N/R). For the very low offsets, the phase noise will be mostly determined by the external reference.

Optimum loop cutoff frequency for the phase noise is the offset value at which the free running VCO phase noise is approximately equal to the sum of the phase noise of the phase detector increased by the 20LOG(N) and the phase noise of the external reference (crystal) oscillator increased by 20LOG(N/R). The task of optimization of the PLL for the phase noise becomes more complicated if the PLL dynamic performance (switching time) and/or spurious suppression are also specified. The compromise between the phase noise performance, loop dynamic characteristics, and spurious suppression should be found.

Q. Can you explain frequency deviation?

A. Frequency deviation is how far the center frequency of the oscillator will change as a function of the control voltage.

Figure 1



Block diagram of a phase locked loop

Q. What is FM noise or phase noise?

A. FM noise or phase noise refers to the short term random frequency fluctuations of a signal. There is a direct relationship between FM noise and phase noise since frequency deviation is equal to the rate of change of phase deviation (see Application Note 2). Mini-Circuits measures single sideband phase noise for characterizing short term stability of a signal, since small FM deviations are difficult to measure.

Q. What is AM noise and how is it caused?

A. AM refers to the amplitude fluctuations of the signal and is caused by bias current noise fluctuations and supply voltage variations. The AM component caused by collector current noise fluctuations may be approximated as follows. For a collector current of Ic, the shot noise component is 2 qIc where q is the charge on the electron. The percentage of AM due to shot noise component is therefore: $(2(2qI_c).100)/I_c$. For 10 mA of collector current, the percentage of AM is therefore 6.4×10^{-19}, which is -182 dBc below the carrier. The AM noise component is therefore small and can be neglected. The most common source of spurious amplitude modulation is the DC power supply. A 0.1% change in the resonator voltage corresponds to ±0.1% AM on the carrier, which is corresponding to a modulation depth of 0.1/200=0.0005. This is therefore 20 $\log_{10}(0.0005)$=-66dB below the carrier. Thus, supply voltage noise should be kept to a minimum.

Q. What is wide band noise floor?

A. A VCO consists of a tank circuit and a positive feedback amplifier. For offset frequencies greater than the VCOs half bandwidth, $f_o/2Q_L$, the phase noise has no positive feedback and is determined only by the ratio of the oscillator signal level and thermal amplifier noise. If we assume an 18dB gain for the amplifier, and 6dB for the noise figure of the amplifier, the noise of the amplifier at its output is given by:

$$N_o = (-174 + 18 + 6)\ \text{dBm/Hz}$$
$$= -150\ \text{dBm/Hz}$$

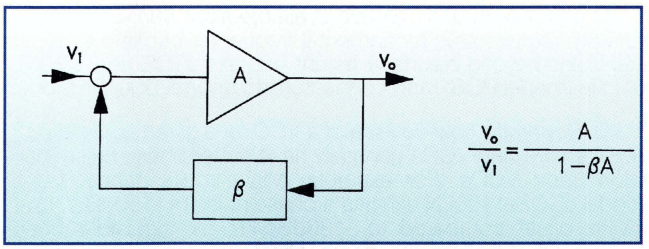
Here, -174dBm/Hz represents the input thermal noise power. To minimize the effect of power supply noise, a low noise power supply should be used. Power supply filtering is discussed in Application Note 3. For an oscillator generating 10mW of power, the carrier to noise ratio is given by:

$$C/N = 10 - (-150)\ \text{dBc/Hz}$$
$$= 160\ \text{dBc/Hz}$$

Q. How can the VCO influence phase noise in a communication system, such as cellular or PCN?

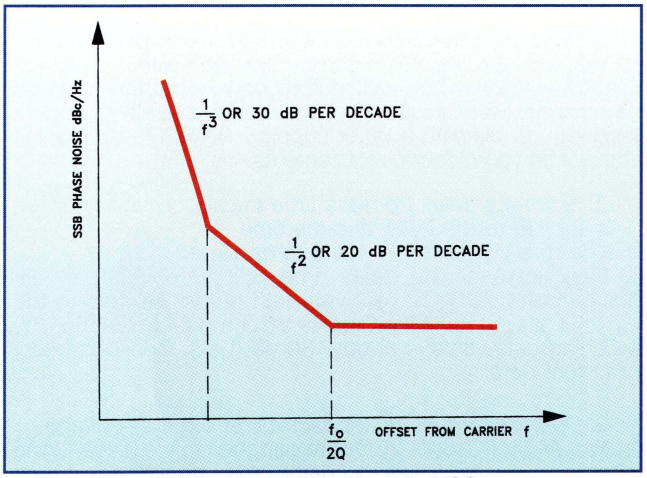
A. A VCO used in a PLL acts as a stable local oscillator. When this is used for down conversion, the phase noise of the VCO and the incoming RF signal are added together with the thermal noise of the mixer resulting in the effective noise of the down converted signal. So, to keep the total noise low, the VCO should have lower phase noise. The noise level that can be tolerated is dictated by system considerations. For low noise VCOs manufactured by Mini-Circuits, the noise is typically -150dBc/Hz to -160dBc/Hz, as exhibited in models JCOS-1100LN and JCOS-1100LN-1 (latter is a non-catalog special) compared to the wide band oscillators, which are typically -136dBc/Hz at 1MHz offset, such as model POS-1025. Mini-Circuits offers a series of low noise VCOs. Refer to catalog or call for details.

Figure 2



An oscillator may be modeled as the combination of an amplifier and a feedback loop

Figure 3



Phase noise characterization of a VCO

Q. How do I minimize phase noise, and would a narrower range VCO, in general, improve the noise characteristics of my system?

A. A VCO may be modeled as a tank circuit and a positive feed back amplifier (Figure 2). The oscillators half bandwidth is $f_o/2Q_L$ where f_o is the center frequency and Q_L is the loaded Q of the tank circuit. For frequencies within the range

$$f_{fl} < f < \frac{f_o}{2Q_L}$$

the phase noise will increase at 20dB per decade where f_{fl} is the frequency at which 1/f flicker noise starts to dominate. For frequencies less than f_{fl}, the phase noise will increase by 30dB per decade. This is illustrated in Figure 3. Close in phase noise is therefore directly related to the Q of the resonant circuit. High Q or cavity type oscillators provide lower close in noise compared to low Q VCOs. Also, lower close in noise can be obtained from silicon transistors. Mini-Circuits uses silicon bipolar transistors for fundamental oscillators. For low noise applications, narrow band VCOs are recommended. Mini-Circuits has designed very low noise VCOs using ceramic resonators. They are models JCOS-820WLN, JCOS-820BLN, and JCOS-1100LN. These VCOs are particularly suitable for applications in wireless products.

Q. What are the benefits of wide band VCOs?

A. Wide band VCOs can be used in a variety of applications. The following list outlines some of the benefits of wide band VCOs.

1. In applications such as radar and electronic counter measures, wide band VCOs provide fast tuning and wide frequency coverage.
2. Fewer VCOs are needed to cover a given frequency range.
3. A standard VCO can be used as a general purpose oscillator for a variety of applications. This can result in cost benefits.
4. Some of the wide band applications can be achieved without resorting to switching VCOs.
5. When frequency pulling is significant enough to shift the VCO outside of its frequency range, a wide band VCO can more easily accommodate the correction to the frequency shift.

Q. What is the best way to specify output power requirements?

A. Output power is usually measured into a 50 ohm load. Output power requirements should be specified in dBm, and tolerances in ±dB.

Q. Can you give me an explanation about tuning slope?

A. This is the slope of the frequency to voltage tuning characteristic at any point and is the same as frequency sensitivity. The slope could be positive or negative. For a positive slope, the output frequency increases as the tuning voltage increases. Similarly for a negative slope, the output frequency decreases as the tuning voltage increases (see Figure 4). Note that the sensitivity should not be less then zero to avoid mal-functions such as phase noise degradations. Spurious (unwanted products) suppression is at least 60dBc bellow carrier at all frequency ranges and beyond. For special requests, consult factory.

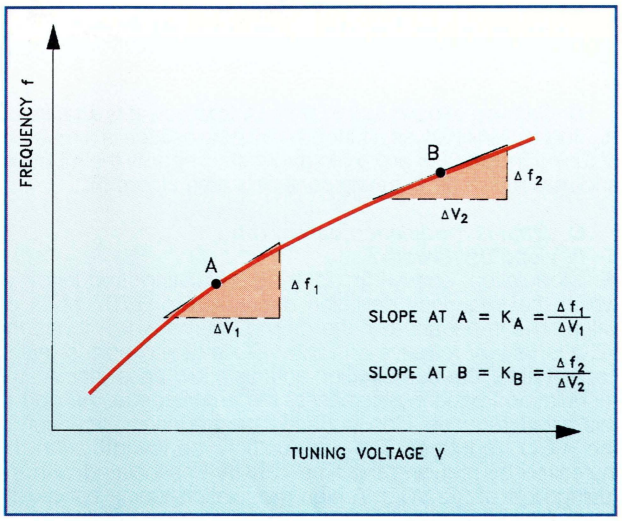
Q. What is monotonic tuning?

A. A monotonic tuning characteristic means that the frequency is single valued at any tuning voltage and that the slope has the same sign across the tuning range. Note that the sensitivity should not be less then zero to avoid mal-functions such as phase noise degradations. Spurious (unwanted products) suppression is at least 60dBc below carrier at all frequency ranges and beyond. For special requests, consult factory. All Mini-Circuits VCOs have a monotonic tuning characteristic and have a positive slope (see Figure 4).

Q. Are custom VCOs available from Mini-Circuits?

A. Yes. Custom VCOs engineered with specifications different than standard catalog models are available from Mini-Circuits. Such requests can best be communicated by completing the Specification Check List on page 114 and sending it to Mini-Circuits applications department. Our applications engineers stand ready to knowledgeably respond to your custom VCO requirements with lightning fast response, low prices and quick turnaround.

Figure 4



Tuning voltage characteristic of a typical VCO

Q. How does tuning linearity manifest itself in FM/PM transmitters?

A. In FM/PM transmitters, the information is transmitted by modulating the carrier frequency of the VCO. A modulating signal at the tuning port modulates the VCO and produces modulation sidebands. These sidebands can be seen using a spectrum analyzer. In general, a modulating signal $V_0 Sin(f_m t)$ produces sidebands which are 20 log $(V_0.K/1.414f_m)$ below the carrier. Here, K is the VCO modulation sensitivity. If V_0 and f_m are kept constant, and the VCO frequency is changed over its range from its low value to its high value, or vice versa, the side band level relative to the carrier will change. The relative change of the sideband level gives an indication of how constant K is, which is the modulation sensitivity.

Q. I notice Mini-Circuits VCOs have lower harmonic content than the competition. What is your secret?

A. All octave band VCOs typically have 8 to 10dB second harmonic suppression. This is not adequate for certain applications. Some Mini-Circuits POS and JTOS models use tracking filters to increase harmonic suppression to typically 20dB or better. Refer to model data sheets to determine the oscillators with higher harmonic suppression.

Q. What is the operating temperature range of Mini-Circuits VCOs?

A. All Mini-Circuits VCOs are designed to operate over the temperature range of -55°C to +85°C.

Q. Are Mini-Circuits VCOs moisture resistant?

A. POS models are hermetically sealed therefore, no moisture can get in.

Q. Can you explain tuning linearity and how it is specified?

A. Tuning sensitivity as a function of tuning voltage is a measure of tuning linearity. For any given application, specify the minimum and maximum of the tuning sensitivity (see Figure 5).

Q. What is modulation bandwidth or video bandwidth?

A. Modulation bandwidth is the modulating frequency at which the frequency deviation decreases to 0.707 of its dc value. The impedance of the driving source which tunes the VCO is usually resistive and the VCO"s tuning port is mainly capacitative. The combination acts as a low pass filter. As the modulation frequency increases, the amplitude at the port of this "filter" reduces. Consequently, the frequency deviation of the VCO reduces. The modulation bandwidth can be increased by reducing the time constant associated with the tuning port of the VCO. A high modulation/tuning bandwidth is required for fast tuning VCOs.

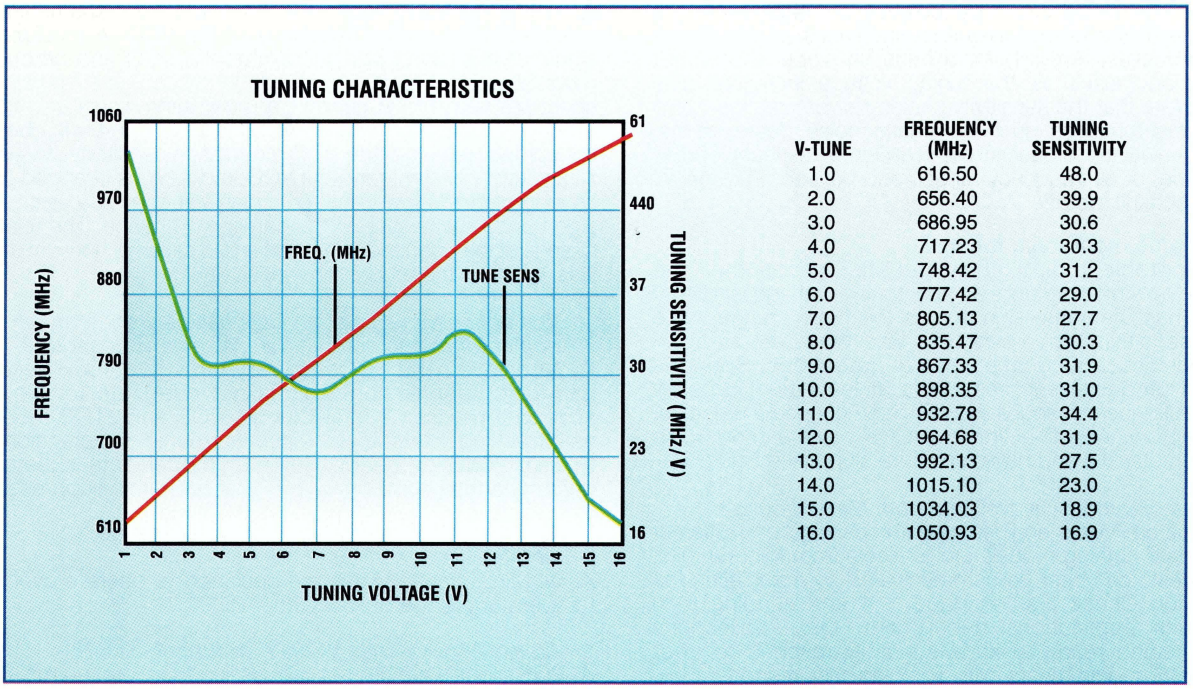
Q. What is the modulation bandwidth of Mini-Circuits VCOs?

A. Most Mini-Circuits VCOs are designed to have a 90kHz modulation bandwidth or higher. For example, in model POS-1060, the modulation bandwidth is 1MHz typical.

Q. I need to ask questions about VCOs, who can I ask?

A. Mini-Circuits applications engineers are prepared to respond to VCO questions and challenges posed by customers, including questions regarding specs, performance, and applications of our products and your designs. Actual measured performance data may be obtained from "YONI" on the Mini-Circuits web site, and our enormous database is offered at no extra charge to eliminate any need for guesswork. Wherever possible, we will courteously recommend a catalog component or help with a custom solution.

Figure 5



V-TUNE	FREQUENCY (MHz)	TUNING SENSITIVITY
1.0	616.50	48.0
2.0	656.40	39.9
3.0	686.95	30.6
4.0	717.23	30.3
5.0	748.42	31.2
6.0	777.42	29.0
7.0	805.13	27.7
8.0	835.47	30.3
9.0	867.33	31.9
10.0	898.35	31.0
11.0	932.78	34.4
12.0	964.68	31.9
13.0	992.13	27.5
14.0	1015.10	23.0
15.0	1034.03	18.9
16.0	1050.93	16.9

Wide Modulation Bandwidth Measurements Technical Note 8

Introduction:

Frequency of a voltage controlled oscillator is proportional to the amplitude of the tuning voltage. Hence, it can be treated as an FM modulator. Every VCO has a tuning voltage range specified. When the tuning voltage is changed at a slow rate, the VCO responds to the voltage changes faithfully. When the rate of change of control port voltage is increased, the VCO frequency may not follow as faithfully. The frequency deviation produced for a given voltage swing reduces as the frequency of the control voltage increases. The frequency at which the frequency deviation reduces to 0.707 (or –3dB) of the DC or low frequency value is a measure of the frequency response of the control port. As the frequency response of the control port is low pass in nature, it is equal to the 3-dB modulation bandwidth. Measurement of the wide modulation bandwidths is not an easy task. Many of Mini Circuits VCOs have very wide modulation bandwidths, which is useful in angle modulation communication systems. This application note explains the theory and the method of measurement of wide modulation bandwidth.

Theory:

Let a DC voltage be applied to the control port of the VCO. This results in a frequency f_0. Now apply a sinusoidal voltage of frequency f_{mod} and amplitude v_{mod} on top of this DC voltage. This result is an FM modulated signal at the output of the VCO and is given by:

$$\text{Vout} = V \sin(\omega_0 t + \int 2\Pi\, k_v * v_{mod} \cos(\omega_{mod} t)dt) \quad (1)$$

Where:

k_v is the tuning sensitivity of the VCO in Hz/V,

$\omega_{mod} = 2\Pi f_{mod}$

and $\omega_0 = 2\Pi f_0$

From FM theory, modulation index β =

= is defined as: β= (Frequency deviation/ f_{mod})

$$= (\text{Tuning Sensitivity} * v_{mod})/ f_{mod} = (k_v * v_{mod})/ f_{mod} \quad (2)$$

Hence, equation (1) can be rewritten as :

$$\text{Vout} = V \sin(\omega_0 t + \beta * \sin(\omega_{mod} t)) \quad (3)$$

Which can be expanded as :

$$\begin{aligned}\text{Vout} = V(& J_0(\beta)\cos(\omega_0 t) - \\ & J_1(\beta)[\cos(\omega_0 t - \omega_{mod} t) - \cos(\omega_0 t + \omega_{mod} t)] + \\ & J_2(\beta)[\cos(\omega_0 t - 2\omega_{mod} t) + \cos(\omega_0 t + 2\omega_{mod} t)] - \\ & J_3(\beta)[\cos(\omega_0 t - 3\omega_{mod} t) - \cos(\omega_0 t + 3\omega_{mod} t)] + \ldots.\end{aligned} \quad (4)$$

As can be seen from equation (4), the output of the VCO may consist of a carrier signal f_0 and sideband signals spaced at $n*f_{mod}$ on either side of the carrier, where n is an integer.

The amplitude of the sideband signal is proportional to the nth order Bessel function $J_n(\beta)$ and is given by:

$$J_n(\beta) = \sum_{k=1}^{\infty} \frac{(-1)^k}{k!*(n+k)!} * (\beta/2)^{(n+2*k)} \quad (5)$$

The carrier amplitude is proportional to the $J_0(\beta)$, the first sideband amplitude – to the $J_1(\beta)$, etc.

In an ideal VCO of infinite modulation bandwidth, if the amplitude of the modulating signal and f_{mod} are increased proportionally to keep the ratio v_{mod}/ f_{mod} constant, the modulation index will remain constant and so will the amplitude of the carrier and sideband signals. In practice, this does not continue indefinitely. As the frequency response of the control port of the VCO starts to become affected, the modulation index starts decreasing or the effective deviation of the modulating signal is decreasing. When it is 0.707 of the initial "slow" deviation value, we have effectively reached the 3dB response of the control port. Properties of the Bessel functions along with the principle described is used in the modulation bandwidth measurements.

Fig 1 shows a plot of the Bessel function for various values of "n" as function of the modulation index. As can be seen in fig 1, the carrier amplitude is equal to zero when the modulation index is approximately equal to 2.4. This feature is very convenient to use as the specific reference point and it is used in method 1 of the modulation bandwidth measurements.

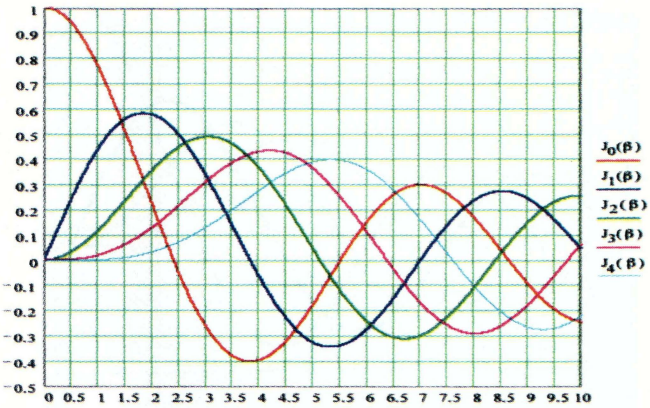


Fig1: Plot of Bessel function vs. modulation index

METHOD 1:
Block diagram of an experimental set up is shown in fig 2.

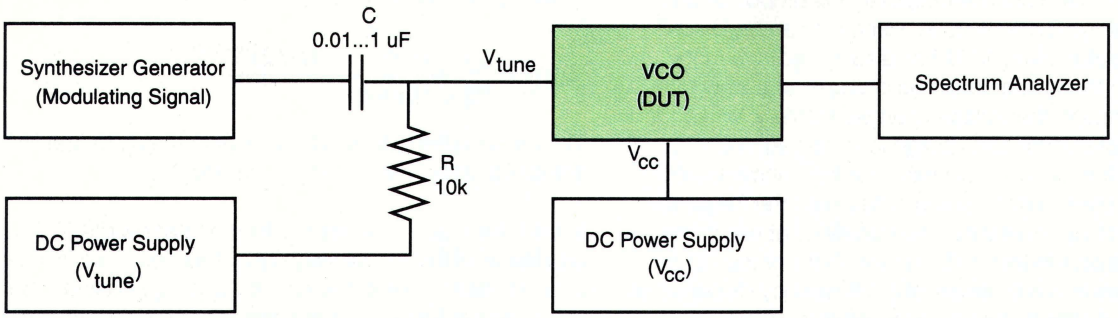


Fig. 2: Wide Modulation Bandwidth Setup.

A modulating signal is applied to the DUT along with a quiescent DC voltage. DC power supply feeds the V_{cc}. Rearranging equation (2), we get

$$v_{mod} = (\beta * f_{mod}) / k_v \qquad (6)$$

The output of the VCO is applied to the Spectrum Analyzer. The frequency of the modulating signal is set to at least a tenth of the anticipated modulating bandwidth.
In the experimental set up in fig. 2, turn off v_{mod} and adjust the spectrum analyzer display to set the carrier to the top of the spectrum display. See fig 3 for an example.

Now, set the f_{mod} to a tenth of the anticipated 3dB modulation bandwidth. Calculate the amplitude of the v_{mod} required to achieve a modulation index of 2.4 from equation (6) and set this amplitude. The carrier should be suppressed completely. If required, fine tune the v_{mod} until the carrier is completely suppressed. In practice, a 30 dB suppression is good enough. This should correspond to a modulation index of 2.4.
See fig. 4 for a typical spectrum display at this condition.

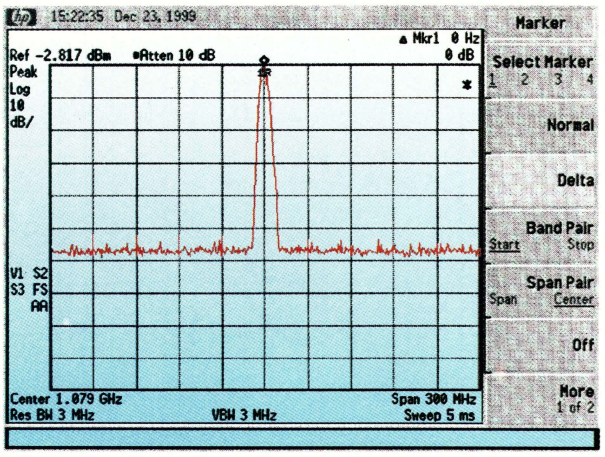


Fig. 3. Output RF signal without modulation.

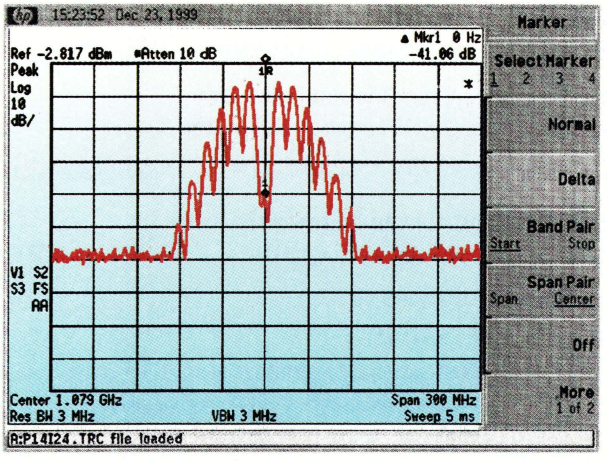


Fig. 4. Output RF signal with the modulation Index equal to 2.4 applied .

Now, the task is to find the modulating frequency which degrades the modulation index to 1.697 (0.707 of 2.4). Slowly increase the modulating frequency and the amplitude of the modulating signal keeping the ratio of v_{mod}/f_{mod} constant. As the 3dB modulation bandwidth is approached, the modulation index starts degrading and this results in increase of the carrier. When the modulation index is equal to 1.697, the carrier level (equation 3) is 0.4 or it is –8dBc with the reference to the unmodulated carrier(see fig 5).

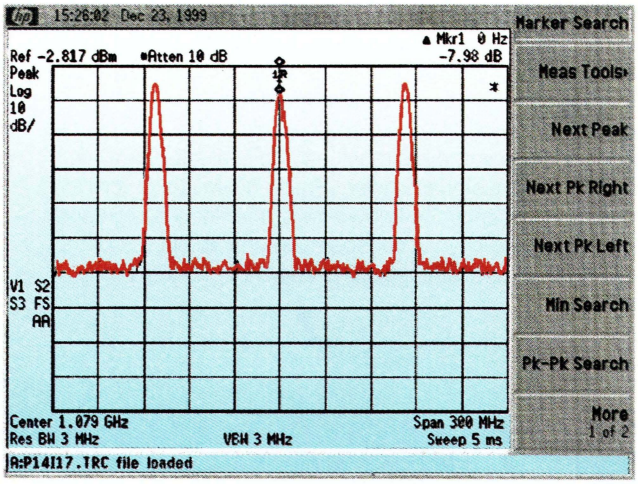


*Fig. 5 Output RF signal with the modulation Index equal to 1.697= 0.707 *2.4 applied.*

At this time the modulating frequency is numerically equal to the modulation bandwidth, as the frequency response is assumed to be low pass in nature.

If the selection of the initial frequency is wrong, erroneous results may be achieved. This is true especially if the initial frequency is too close to the 3 dB frequency. To prevent this, repeat the above measurement at half the initial value. If the results are within measurement error, good measurements are made.

Alternate methods:

METHOD 2:

Set the v_{mod}/f_{mod} to get a modulation index of 2.4 to get carrier suppression as in method 1. Now increase the amplitude of v_{mod} by 1.414 to get a modulation index of 3.4. Then increase f_{mod}, and vmod keeping the ratio constant. When the modulation bandwidth is degraded by 0.707 to 2.4, the carrier is fully suppressed and 3 dB bandwidth has been reached.

METHOD 3:

Other properties of Bessel functions can be used to do the above measurements. For example, start with a modulation index of 1.44. At this point, the amplitudes of the carrier and the first order sidebands should be equal. Now measure the amplitude of the modulating signal and increase it by 1.414 times (inverse of 0.707) of the measured value. This increases the modulation index by 1.414. Now increase the amplitude of the modulating signal and the modulating frequency simultaneously, keeping the ratio constant. When the 3 dB frequency has reached, the carrier and sideband amplitudes are equal again.

Optimizing VCO/PLL Evaluations & PLL Synthesizer Designs *Technical Note 9*

Today's mobile communications systems demand higher communication quality, higher data rates, higher frequency operation, and more channels per unit bandwidth. As much of this equipment is portable, low power consumption and small size are also required. All of these constraints combine to make the whole design including component selection and evaluation quite challenging. One portion of this design that is very critical with regard to all of the requirements mentioned above is the synthesized oscillator. Typical synthesized oscillators combine a Voltage Controlled Oscillator (VCO) with a Phase-Locked Loop IC (PLL), frequency reference (e.g. Crystal / TCXO) and a loop filter. The VCO is used to generate the RF output frequency. The PLL (which is of the "analog type"; i.e. different from a pure digital PLL) is used to stabilize and control the frequency. The loop filter design must integrate all of the components to establish, among other things, a tradeoff between noise and transient response (Figure 1). Within this paper we will describe the evaluation of the PLL and VCO and relate those evaluations to information that will allow the circuit designer to optimize the whole oscillator design including the loop filter.

1. VCO characteristic parameters and problems with the conventional evaluation method

Shown below are many of the common VCO evaluation parameters. To perform these evaluations, many instruments and set-ups are required even including special DC sources for both the power supply and tuning voltage.

1) RF frequency [Hz]
2) RF power [dBm]
3) Phase noise [dBc/Hz]
4) Residual FM [Hz rms]
5) DC consumption current [mA]
6) Tuning sensitivity [Hz/V]
7) Harmonic/spurious [dBc]
8) Frequency pushing [Hz/V] and frequency pulling [Hz p-p]

To achieve optimal circuit performance, many VCO characteristics should be evaluated under varying conditions. For example, a very fundamental parameter is the VCO output frequency versus tuning voltage (F-V). One extension of this parameter is tuning sensitivity (Hz/V), which is the differential of the F-V curve. Ideally this is a constant, but it is not. The slope change, as a function of frequency, is very important to know since this is a critical design parameter for the loop filter. But both of these parameters should also be evaluated under different power supply (Vcc) conditions since the output frequency may shift with Vcc changes. This DC power sensitivity is called frequency pushing. The RF power output will also be a function of both Vcc and output frequency. This should be evaluated since too low of an output power will result in excessive noise and too high of a level will create distortion and consume excess DC power. In addition, the DC power sensitivity has the opportunity to translate Vcc noise into modulation/noise of the oscillator output.

Many other parameters must also be evaluated; not the least of which is phase noise. Phase noise is a crucial parameter. It must be known for proper loop design and it will impact many critical operating characteristics of the synthesized oscillator including adjacent channel power.

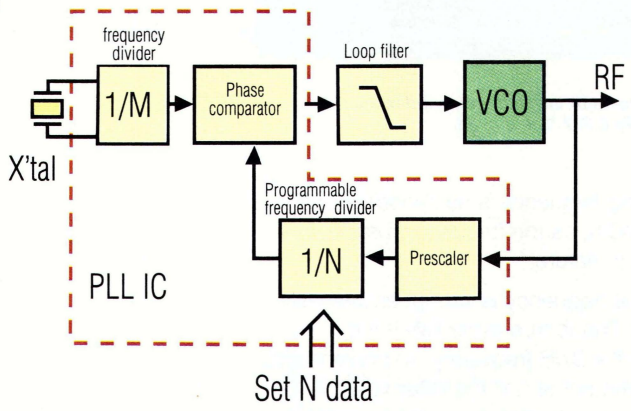


Figure 1: Basic block diagram of PLL frequency synthesizer

Article Courtesy Agilent™ Technologies

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DC control voltage source noise

Noise on the DC tuning/control voltage source affects the VCO phase noise measurements since it is the VCO's job to take any control voltage variation and translate that into a frequency variation (Figure 2). For this reason the source must be very low noise, which is typically accomplished through the use of a low-pass filter. Choosing a very low cut-off frequency for this filter will yield very good noise rejection, but it will also reduce the source agility (i.e. slower frequency sweep rate) and reduce measurement accuracy. So while the filter solves some problems and may be necessary, it also creates some problems.

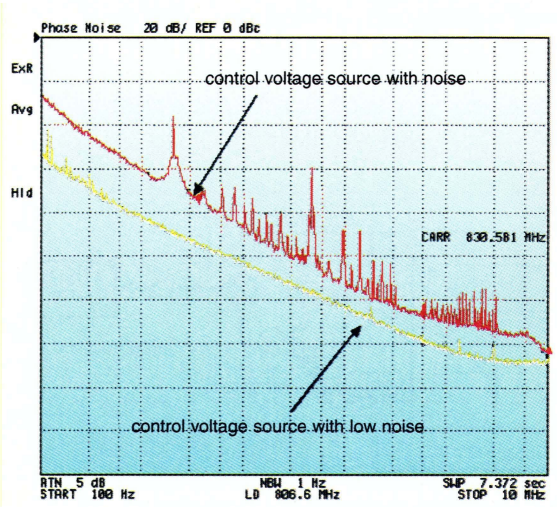


Figure 2: DC control voltage source noise affecting phase noise measurement

VCO frequency stability and phase noise characteristic evaluation

Phase noise is a random noise expressed as the ratio of the "power spectrum density at a specified offset frequency" to the "carrier signal level". This is a very sensitive measurement, so averaging is typically required to ensure measurement repeatability. Phase noise measurements can be made by both spectrum analyzers and by dedicated phase noise measurement systems.

One issue with traditional phase noise measurements of the VCO is that the output frequency of these devices when they are not locked by a PLL drifts substantially over the measurement time. The VCOs are very sensitive devices and will encounter drift due to small thermal changes and even vibration. This carrier drift creates significant error that can only partially be corrected through extensive averaging (Figure 3).

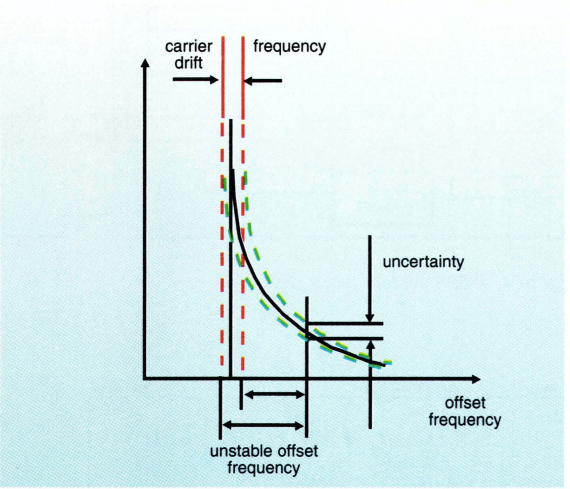


Figure 3: Carrier drift affecting phase noise measurement

Another issue is the noise measurement range. As mentioned above, spectrum analyzers can be used to measure phase noise. Aside from the drift issue mentioned above, spectrum analyzers often do not have a low enough noise floor to evaluate many of the devices required in today's communication systems.

Phase noise and phase jitter

Phase jitter causes transmit and receive timing errors and irregular sampling that results in distance, quantity, and bit errors. Phase jitter will show itself as residual phase modulation. Dedicated phase noise measurement equipment has special calculation capabilities to determine phase jitter from the phase noise measurement data.

2. VCO Characteristics evaluation using Agilent 4352S VCO/PLL signal test system

VCO measurement capabilities of the 4352S

The Agilent 4352S is a self-contained solution for performing virtually all measurements required for thorough VCO evaluation (Figure 4). Specialized sources and measurement equipment have been combined to achieve this dedicated task with ease and accuracy. For example, the system contains a low noise power supply to power the DUT and an ultra low noise DC tuning / control voltage source (Figures 5 & 6). The system is integrated and includes the switching and firmware to perform all of the following tests accurately and with ease.

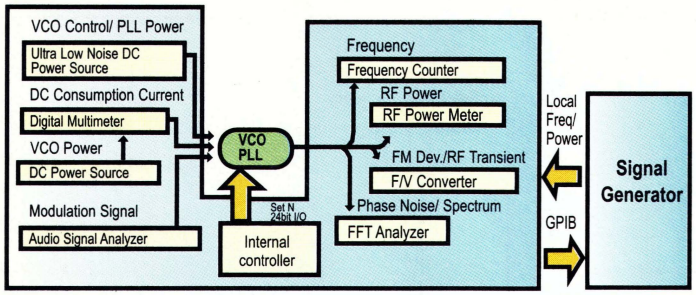


Figure 4: 4352S system block diagram

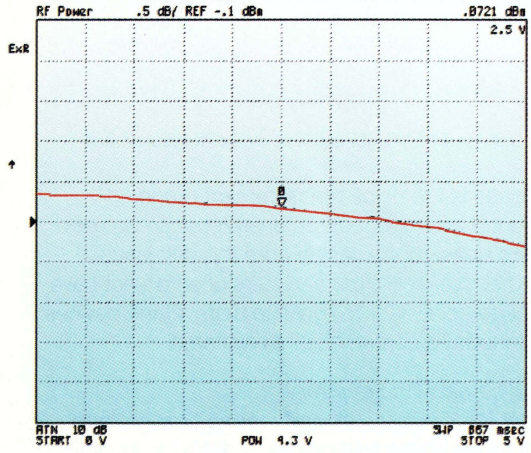


Figure 5: RF power vs. DC control voltage characteristic measurement

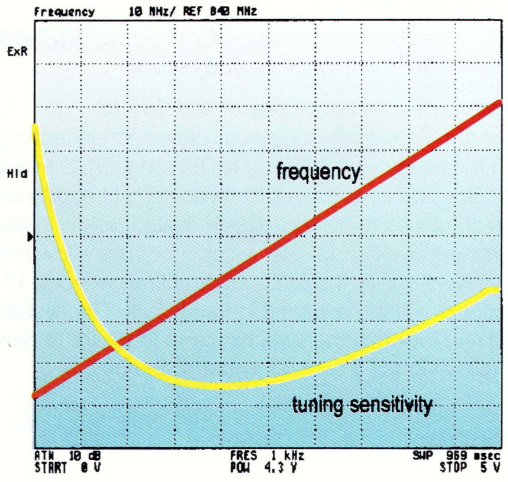


Figure 6: RF frequency vs. DC control voltage characteristic measurement

High speed SSB phase noise measurement function and automatic frequency control function

The 4352S includes a "carrier lock multi-mode PLL circuit", developed for high-speed phase noise measurements. The stepped FFT technique and the ultra low noise DC control voltage source, enable fast and easy VCO phase noise measurements. Figure 7 shows the block diagram of the carrier lock multi-mode PLL circuit. The VCO frequency is measured, and then the carrier frequency is translated into IF of 24 MHz through the mixer, with the local signal from the external signal source. The phase noise of the signal is measured in the carrier lock multi-mode PLL circuit with the orthogonal phase detection method. This phase noise measurement circuit continually locks to the drifting carrier frequency enabling quick and accurate phase noise measurement with high repeatability. Because the 4352S automatically controls all necessary settings, including the external signal source frequency, the phase noise measurement can be easily made (Figure 8).

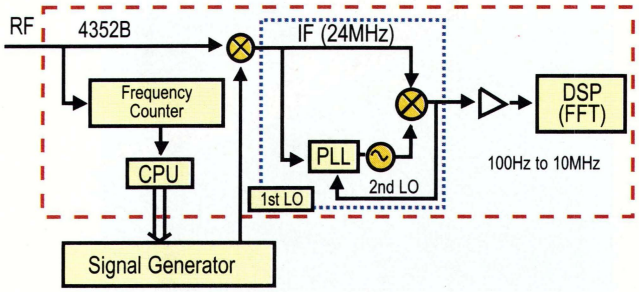


Figure 7: Carrier lock multi-mode PLL block diagram

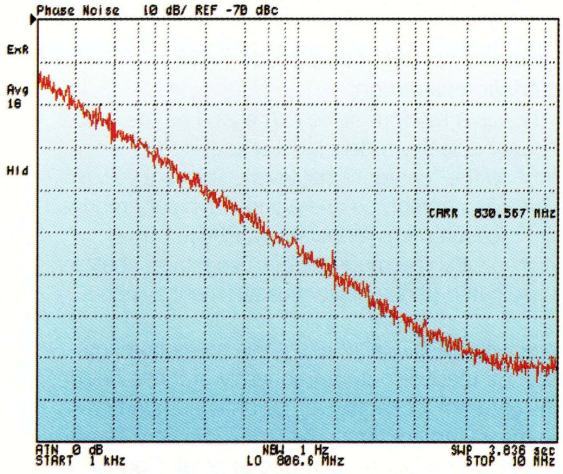


Figure 8: Example of VCO phase noise measurement using the 4352S

The 4352S Automatic Frequency Control, which operates with the built-in frequency counter and DC tuning voltage source, automatically controls the DC tuning voltage. Therefore, VCO phase noise at a specific carrier frequency can easily be measured by directly entering the desired frequency (Figure 9).

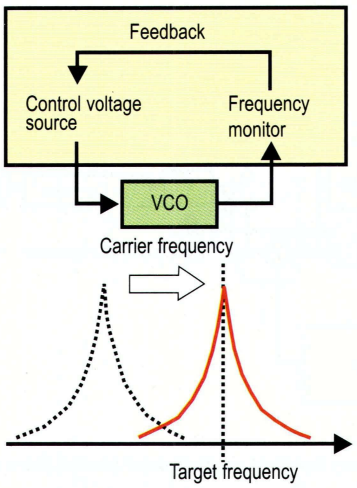


Figure 9: Automatic frequency control function

Integrated phase noise measurement function and phase jitter calculation

The 4352S can display phase noise and integrated phase noise power within the specified frequency range, on the same screen, for improved development and design efficiency. Figure 10 shows an example of an integrated phase noise measurement. (The total phase noise power [dBc] within the cursor-specified offset frequency range (1 kHz) appears at the lower left corner of the screen.)

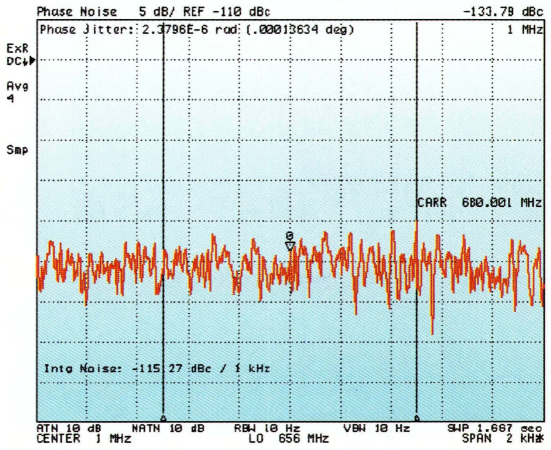


Figure 10: Integrated phase noise power measurement using the 4352S

3. PLL characteristic evaluation parameters

PLL frequency synthesizer measurement parameters

The lockup time and the spurious response of the PLL frequency synthesizer are in trade-off relationship with each other. Since a PLL frequency synthesizer typically consists of many components, it is important to consider the possible variations of each component parameter to ensure a high quality manufacturing process. The following parameters have to be evaluated for the design of an optimal loop filter, necessary in the PLL prototyping stage.

1) Frequency [Hz]
2) RF Power [dBm]
3) Phase noise [dBc/Hz]
4) Reference leak (spurious characteristic) [dBc]
5) Lockup time [sec]
6) Loop bandwidth

Measurement system and setup change

PLL frequency synthesizer performance evaluation generally requires a variety of measurement instruments including the following:

1) Modulation domain analyzer for lockup time measurement
2) Phase noise measurement system
3) Spectrum analyzer for spurious characteristic evaluation
4) Controller for the PLL

Performance verification of the measurement system, after every connection change, is necessary for repeatable measurements. When the loop filter characteristics or oscillation frequency is changed, measurement configurations and setup must also be changed. This tedious work may result in long product development time. Since the PLL frequency synthesizer is set to a desired frequency, by digitally controlling the PLL IC chip, a PLL control circuit or a PLL control program is necessary. It is, therefore, impossible to start the synthesizer evaluation until either the control circuit or the program is complete. Because it is difficult to synchronize measurements with a PLL frequency change, PLL lockup time measurement accuracy is difficult to achieve.

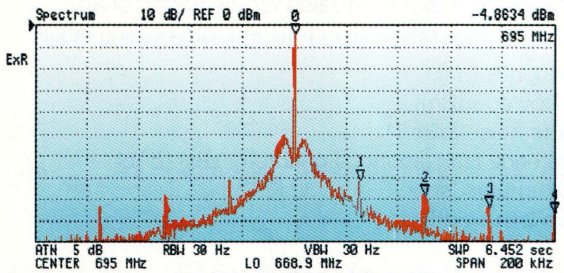
Time and frequency resolution during frequency transient measurement

PLL lockup time measurements and frequency transient analysis are conventionally performed with a modulation domain analyzer. In which case, the frequency resolution depends on the sampling interval and the measurement frequency.

4. PLL characteristic evaluation using the Agilent 4352S

All-in-one measurement system architecture

In addition to the VCO measurement functions, the 4352S can control the PLL frequency synthesizer. High-speed phase noise measurements and spectrum measurements can be made without changing connections (Figure 11). The fast phase noise measurement function greatly reduces evaluation time, subsequently improving the loop filter design efficiency.



N	SWP PARAM	VAL
0	695 MHz	-4.8634 dBm
1	695.025 MHz	-72.025 dBm
2	695.05 MHz	-79.182 dBm
3	695.075 MHz	-84.418 dBm
4	695.1 MHz	-87.6 dBm

Figure 11: PLL spurious measurement using the 4352S

Controlling the PLL Using the IBASIC programming and 24-bit digital I/O functions

The 4352S allows the user to set a desired frequency division ratio. The IBASIC programming function and the 24-bit digital I/O port enable the lock-up time measurement to synchronize to the frequency change of the PLL synthesizer, without the need for an external PC (Figure 12).

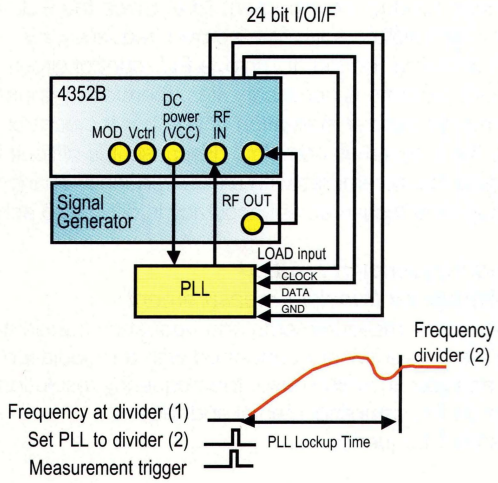


Figure 12: Configuration for PLL IC control and lockup time measurement timing chart

Frequency transient measurement function

Figure 13 shows the block diagram of the 4352S frequency transient measurement. The 4352S uses a frequency discriminate to convert frequency to voltage. This enables ¡frequency transient measurements with both a time resolution of 12.5 microseconds and a frequency resolution of 50 Hz, over the entire measurement frequency range (Figure 14).

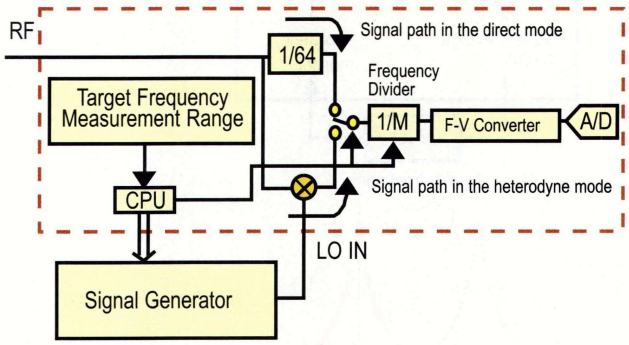


Figure 13: 4352S frequency transient measurement section block diagram

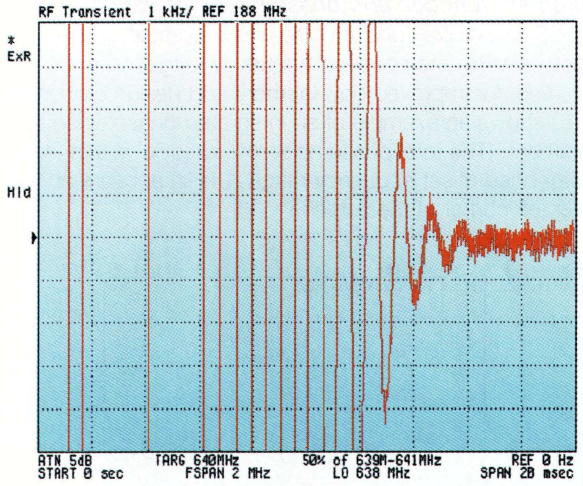


Figure 14: Frequency transient measurement using the 4352S

Spurious and lockup time measurement for designing loop filter

In general, the loop filter design is one of the most critical parts of the whole synthesized oscillator development. The loop filter, which is a low-pass filter inserted between the phase comparator and the VCO control voltage input terminal, eliminates the high frequency component of the phase correction pulse generated by the phase comparator so that only the DC component is provided to the VCO. In general, the lower the loop filter cutoff frequency, the more the reference leak from the phase comparator is suppressed. As a result, the PLL spurious is also suppressed as shown in Figure 15. In addition, a low loop filter cutoff frequency does not suppress phase noise at close-in offset frequencies because the closed loop negative feedback region is narrowed. It makes the PLL response slower (Figure 16) and the settling time of frequency switching (PLL lockup time) longer. Conversely, increasing cutoff frequency provides faster PLL response and shorter PLL lockup time, as shown in Figure 17. While phase noise near the carrier frequency is suppressed, the reference leak is not. It turns out that the PLL output signal is frequency-modulated and contains high level spurs (Figure 18). When performing loop filter design, it is necessary to consider phase noise, spurious, PLL lockup time tradeoffs, loop filter frequency characteristic and some design margin because even VCOs with the same specifications used in the PLL design might have slightly different characteristics. Spurious level, phase noise and frequency transient evaluation, under various conditions, bring successful PLL design and efficiency, which is crucial for shorter development time.

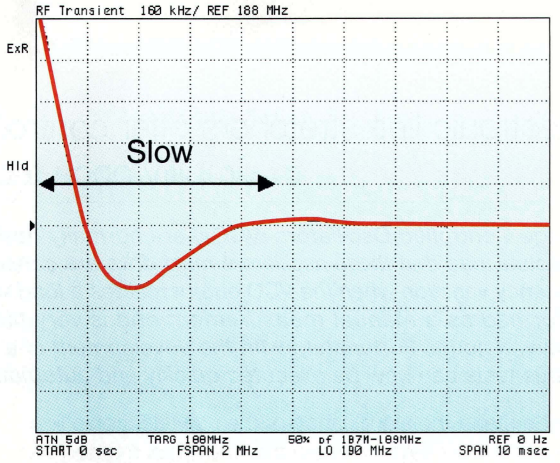


Figure 16: Lockup time characteristic at lower cutoff frequency

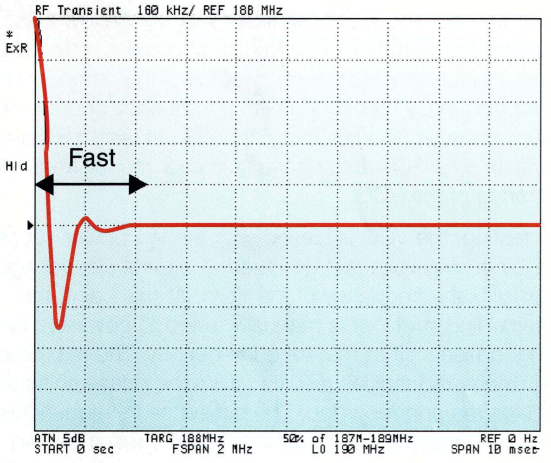


Figure 17: Lockup time characteristic at higher cutoff frequency

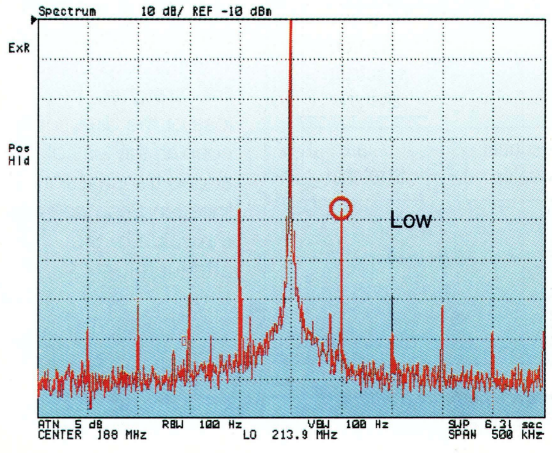


Figure 15: Spurious level characteristic at lower cutoff frequency

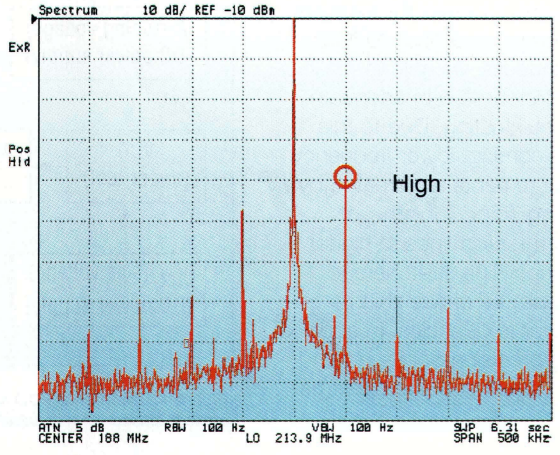


Figure 18: Spurious level characteristic at higher cutoff frequency

Line Stretchers Ease VCO Load-Pull Testing

Technical Note 10

Electronic line stretchers offer controlled phase shifts over wide frequency ranges to simplify once tedious VCO measurements.

Voltage Controlled Oscillators (VCOs) are normally designed for operation in an ideal 50 ohm environment. However, the actual load that these oscillators must drive are considerably different. It is a standard industry practice to measure frequency variation when the VCO output realizes a load with 12dB return loss (for all possible phase angles). This is usually performed as a manual measurement and is very time consuming. It may take a skilled technician several minutes to several hours. Fortunately, with the development of a novel electronic line stretcher from Mini-Circuits, these once tedious tests can now be executed quickly and automatically.

To understand the significance of the new electronic line stretcher, it may help to review the traditional method of performing load pull tests on a VCO. A manual measurement setup for load pull testing of RF and microwave VCOs is shown in Fig. 1. The VCO's RF output is connected through a 6dB attenuator and a directional coupler to the low loss mechanical line stretcher. The directional coupler provides a low level (reduced by the coupling factor of the component) signal for frequency monitoring with a frequency counter or spectrum analyzer. The line stretcher must at least be capable of providing a full 360-deg. phase shift over the full frequency tuning range of the VCO.

During testing, the VCO is biased with the V_{cc} power supply. The VCO's tuning voltage, V_t, is fixed at a particular voltage in order to fix the frequency of the VCO. At this point, the mechanical line stretcher is manually tuned to cover the full 360-deg. phase shift at that tuned frequency. The maximum and minimum frequencies resulting from the phase shifts are then measured and recorded. The difference in frequencies provides the frequency shift of the VCO as a result of load pulling. Mechanical line stretchers which can provide the full 360-deg. phase shift at frequencies above 1000MHz are available. At lower frequencies however, it is difficult to find continuously variable mechanical line stretchers with adequate load pull testing. Due to this short-coming, lower frequency measurements are created by adding fixed lengths of transmission lines to higher frequency line stretchers to increase the phase shift range at lower frequencies. In addition, using precision open-end and short-calibration standards as termination to the line stretcher, additional 180-deg. phase shift can be obtained. For example, a particular mechanical line stretcher can provide a 360-deg. phase shift at 1000MHz. The same line stretcher will only provide a phase shift of 180-deg. at one half the frequency, or 500MHz. To perform load pull testing on a VCO with a carrier frequency of 500MHz, first a frequency extreme search (for the minimum and maximum frequencies) is performed over the 180-deg. range of the line stretcher at 500MHz, with an open standard placed at the end of the line stretcher. The open standard is then replaced with a short standard, which provides an additional phase jump of 180-deg., and the frequency-extreme search is repeated. The minimum and maximum oscillator frequencies from both measurements are used to compute the load pull results.

VCO load pull measurements using this approach can become tedious at lower frequencies. For measurements on a VCO with a carrier frequency of 250MHz and a 1000MHz line stretcher, testing must be performed in four steps. At each step, the open-short techniques must be performed and additional quarter wave-length (at 250MHz) transmission lines added to affect a phase jump of 90-deg. The technician performing the measurements must also take into consideration the additional insertion loss of the line stretcher, the loss of the directional coupler, the loss of the added transmission lines, and compensate the value of the attenuator.

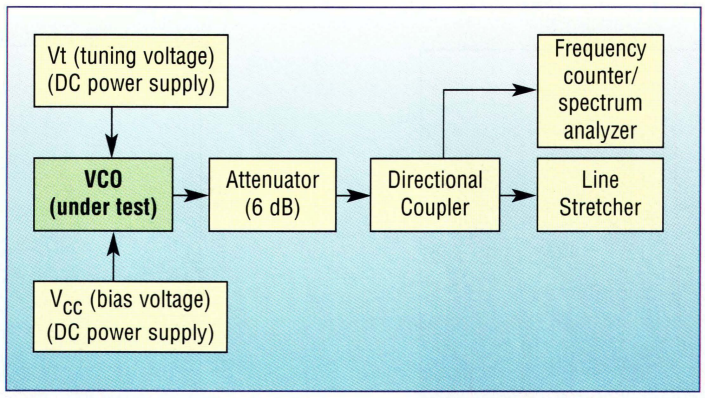


Figure 1. Traditional VCO load-pull measurements are performed with a system based on a manual line stretcher.

Conventional electronic phase shifters can be used for VCO load-pull testing, but these are generally narrowband, with a full 360-deg. phase shift generally available only over a narrow range of a typical VCO's tuning range. In addition, the insertion loss of an electronic phase shift is not constant across the phase-shift range, but tends to enlarge with increasing phase shift. Phase shifters are also subject to distortion as a result of saturation.

Due to shortcomings of conventional electronic phase shifters and mechanical line stretchers, the engineers at Mini-Circuits sought a better method for performing VCO load-pull measurements. This search resulted in development of a line of electronic line stretchers with full 360-deg. phase shifts across wide frequency ranges (see table). The first three models in this line of electronic line stretchers includes units with an octave or more frequency range over a total range of 110 to 1300MHz. These three-port devices feature a nominal return loss of 10 to 12dB, with electronically adjustable phase ranges of better than 360-deg. for the fully specified operating frequency ranges. A monitor port supplies a sample of the output signal of the VCO under test at reduced amplitude for monitoring and testing purposes.

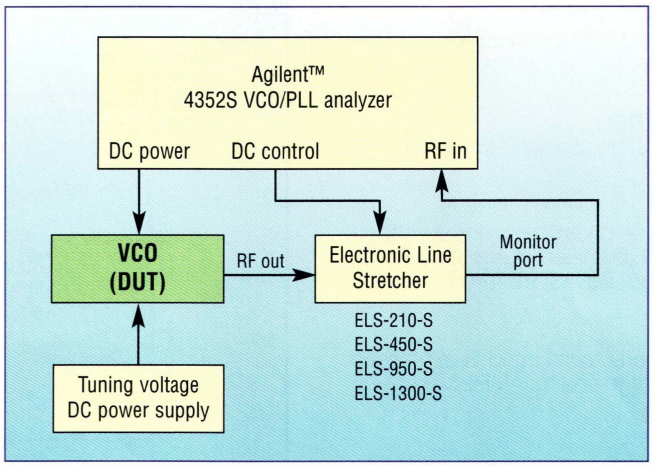


Figure 2. This automated VCO load-pull measurement system is made possible by the electronic line stretchers.

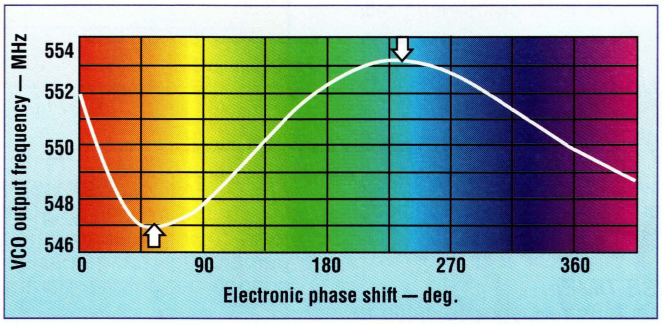


Figure 3. Measurement results show the output frequency as a function of electronic line stretcher phase shift.

The new electronic line stretchers are ideal for use in automated VCO load-pull test setups (Fig. 2).

As the DC control voltage is swept from +0.5 to +25 VDC, the phase angle of the load presented to the VCO changes by more than 360-deg. The VCO/PLL analyzer is set to display the frequency versus DC control voltage (which represents a phase variation of the load). The peak-to-peak difference in the displayed frequency curves provide the load pull (Fig. 3). Each electronic line stretcher is housed in a metal case with female SMA coaxial connectors on all ports. The metal housing measures 1.25"x1.25"x0.75" (3.18x3.18x1.91 cm).

The electronic line stretchers at a glance

Model number	Frequency range (MHz) f_L to f_U	Input power (dBm) (maximum)	Phase range (deg.) (minimum)	Return loss (dB) (typical)	Control voltage (V) (start-stop)
ELS-210-S	110 to 210	10	360	10 to 12	0.5 to 25
ELS-450-S	180 to 450	10	360	10 to 12	0.5 to 25
ELS-950-S	400 to 950	10	360	10 to 12	0.5 to 25
ELS-1300-S	750-1300	10	360	10 to 12	1 to 25

Definition Of VCO Terms Technical Note 11

VOLTAGE CONTROLLED OSCILLATOR (VCO):
This is an oscillator designed so the output frequency can be changed by applying a voltage to its control port or tuning port.

FREQUENCY TUNING CHARACTERISTIC:
Frequency versus tuning voltage performance for a given VCO. This is usually graphed as frequency vs. voltage.

FREQUENCY VS. TEMPERATURE:
Variation of frequency with temperature at a fixed tuning voltage.

MONOTONIC TUNING:
This refers to the fact that for a given frequency voltage characteristic, the frequency is single valued at a given voltage, and vise versa. Refer to Q&A's (pg. 25-28) for further details.

TUNING SENSITIVITY:
This is the slope of the tuning characteristic and is expressed as frequency change per unit voltage change (MHz/V, etc.).

TUNING LINEARITY:
The deviation of the frequency versus tuning voltage characteristic from a best-fit straight line.

TUNING NON-LINEARITY:
The extent to which the tuning voltage characteristic falls outside the best fit straight line.

TUNING OR MODULATION, AND DELTA MODULATION SENSITIVITY:
The slope of the tuning voltage characteristic at a given tuning voltage is the tuning or modulation sensitivity. The difference in modulation sensitivity at two operating tuning voltages is the delta modulation sensitivity. (For additional information, see the Q&A section).

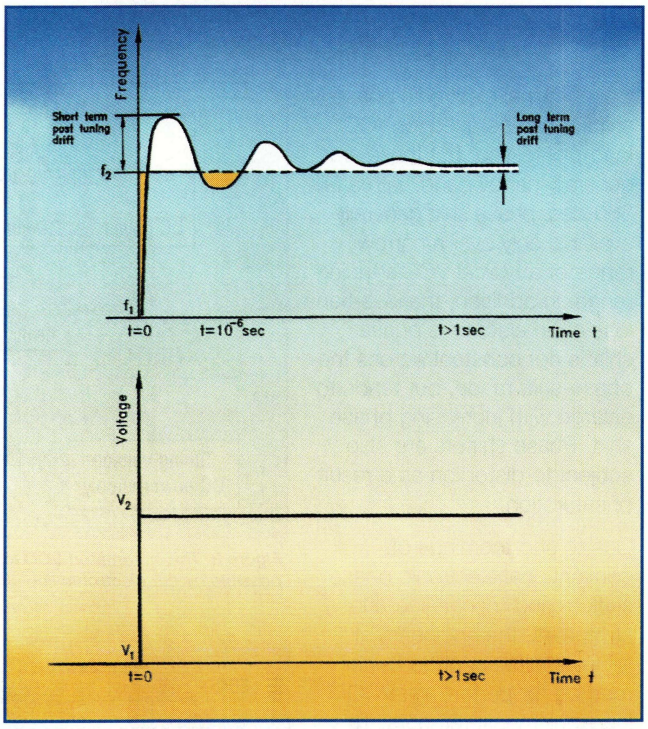
TUNING SPEED (OR RESPONSE TIME):
This is the time required for the output frequency to settle to within 90 percent of its final value after applying a step change in frequency. The settling time or tuning speed is related to the tuning or modulation bandwidth.

VCO INPUT CAPACITANCE:
The total equivalent capacitance seen at the tuning port of the VCO. This parameter is a function of the amplitude and frequency of the test signal at the tuning port.

MODULATION OR TUNING BANDWIDTH:
The modulating frequency at which the frequency deviation decreases to .707 of its dc value. This is usually a function of the modulating source impedance, which is typically 50 ohms.

POST TUNING DRIFT:
The application of a step voltage causes the VCO to change its frequency from an initial f_1 value to a final f_2 value. The frequency f_2 will settle to a stabilized value after some time. Post tuning drift is the frequency error compared to a final stabilized value at a specified time after the application of a step voltage. Expressed as frequency error in Hz, kHz, etc. as illustrated in Figure 1.

Figure 1



Post tuning drift illustration

FREQUENCY DRIFT WITH TEMPERATURE:
This is the frequency drift of the VCO with temperature at a fixed tuning voltage, and may be expressed as a relative percentage change per unit temperature, or as a frequency change per unit temperature.

FREQUENCY PUSHING:
The changing of output frequency corresponding to a given change in the supply voltage at a fixed tuning voltage (expressed in MHz per volt).

FREQUENCY PULLING:
Frequency variation caused by changes due to the output load. Usually specified at a load return loss of 12dB and all possible phases.

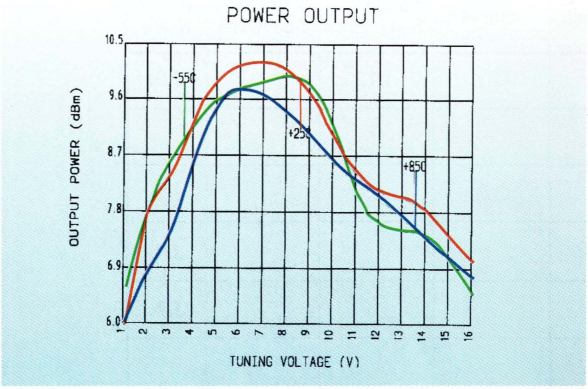
OUTPUT POWER:
The fundamental sinusoidal frequency output of the oscillator measured into a 50 ohm load.

OUTPUT POWER VARIATION:
The maximum to minimum power variation (expressed in dB) observed over the specified frequency range in a 50 ohm system at a given temperature.

OUTPUT POWER FLATNESS:
Variation of the output power from the average output power, expressed in dB.

OUTPUT POWER CHANGE WITH TEMPERATURE:
The change in the output power over the temperature range (example using Mini-Circuits Models POS-765 or JTOS-765 is shown in Figure 2).

Figure 2



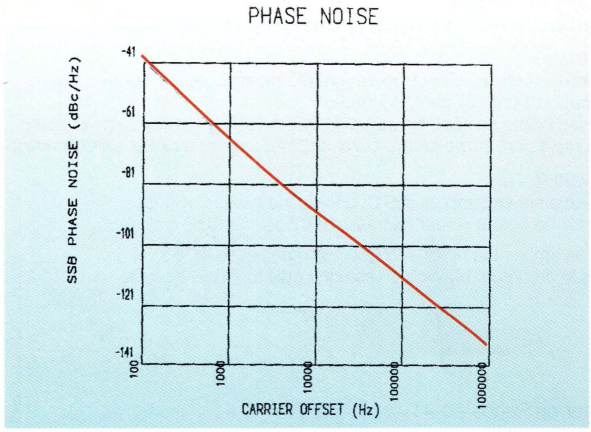
HARMONIC CONTENT OR SUPPRESSION:
Harmonics levels are measured relative to the fundamental signal and expressed in dB referenced to the carrier (dBc).

SPURIOUS RESPONSES OR NON-HARMONIC SPURIOUS CONTENT:
Spurious frequencies are unwanted and non-harmonically related signals present at the oscillator output. Spurious response is usually expressed in terms of dBc.

SSB PHASE NOISE:
Single side band phase noise in 1Hz bandwidth is measured relative to the carrier power at a given offset from the carrier frequency and is expressed as dBc/Hz, as illustrated in Figure 3 (Mini-Circuits models POS-1025 or JTOS-1025). For more information see Application Note 2.

FLICKER NOISE:
One of the sources of noise associated with solid state devices, the amplitude of which varies inversely with frequency. It is also referred to as 1/f noise.

Figure 3



RESIDUAL FM:
This is another form of specifying the frequency stability of a signal source. It is the total rms frequency deviation Δf_{rms} within a given bandwidth: f_a to f_b. The bandwidth is usually specified between 50Hz to 3kHz. Expressed mathematically, we have

$$\Delta f_{rms} = \sqrt{2\int_{f_a}^{f_b} S_c(f) f^2 \delta f}$$

as referred to in Application Note 2.

Q OR QUALITY FACTOR:
A figure of merit often used in describing the sharpness of a tuned circuit response. A high Q circuit has a sharper response, and vice versa.

VARACTOR DIODE:
A diode operated in a reverse biased condition providing a junction capacitance that is a function of the applied reverse bias voltage.

PHASE LOCKED LOOP (PLL):
A feedback circuit in which the VCO frequency and phase is locked to the frequency and phase of a stable reference signal.

FREQUENCY SYNTHESIZER:
A system that generates any one of equally spaced frequencies within a given band, referenced to a stable frequency.

PHASE DETECTOR:
A circuit which compares two coherent RF signals and generates a DC output voltage that is a function of the difference between the phase of two signals.

PHASE DETECTOR GAIN:
This is a constant for a given device, and measured in volts per radian.

BODE PLOT OR BODE DIAGRAM:
A method of describing the transfer characteristic of a circuit or system where the logarithm of the gain function and phase shift is plotted to a logarithmic base of frequency.

UNITY GAIN:
The gain at which the magnitude of the open loop gain is equal to 1 (or 0dB).

UNITY GAIN FREQUENCY:
The frequency at which the magnitude of the open loop gain crosses the 0dB point.

LOOP FILTER:
The loop filter is generally a low pass filter which filters the output of the phase detector and determines the noise characteristics of the VCO. If the phase detector generates a current output, then the loop filter will integrate the output signal from the phase detector into a DC voltage to drive the VCO to a specific frequency. The loop filter may take different forms, such as lag/lead network, etc.

How VCO Parameters Affect Each Other

Technical Note 12

Relationships of VCO Performance Parameters

Affecting Parameter \ Affected Parameter	Frequency Range	Power Output	Tuning Sensitivity	Supply Current	Pushing	Pulling	Power Output Flatness	Harmonics Suppression	Modulation Bandwidth	Phase Noise
Frequency Range			D.1.				C.1.	I.1.		J.2.
Power Output				E.1.						
Tuning Sensitivity	A.2.						C.3.			J.3.
Supply Current		B.1.				G.2.				J.4.
Pushing	A.3.									J.7.
Pulling	A.4.	B.2.		E.2.						
Harmonics Suppression							C.4.			
Temperature	A.5.	B.3.		E.3.				I.2.		J.6.
Frequency					F.1.	G.1.			H.1.	J.1.
Tuning Voltage	A.1.		D.2.				C.2.			J.5.
Power Supply					F.2.					

How To Use This Table

In order to see an explanation on how the "Affecting Parameter" affects the "Affected Parameter":

1. Go to the intersection on the table between the Affecting and Affected parameters (for example, the intersection of how "Frequency Range" affects "Phase Noise" is J.2.").
2. The figure appearing in the intersection ("J.2." in our example) indicates where the explanation on the Effect appears in the text: the letter indicates the Article and the number indicates the Sub-Article (for example, "J.2." refers to Article "J", Sub-Article "2").
3. Empty cells indicate that the effect of the Affecting Parameter on the Affected Parameter is insignificant or does not exist at all.

A. Parameters Affecting VCO Frequency Range

The following parameters affect the VCO Frequency Range.

A.1. TUNING VOLTAGE

- An increase in tuning voltage range widens frequency range.

A.2. TUNING SENSITIVITY

- Lower sensitivity means a narrower frequency range for a given range of tuning voltage.

A.3. PUSHING

- Increased pushing causes decreased effective frequency range.

A.4. PULLING

- Increased pulling causes decreased effective frequency range.

A.5. TEMPERATURE

- An increase in the range of the ambient operating temperature causes a decrease in the VCO's frequency range and vice-versa.

B. Parameters Affecting VCO Power Output.

The following parameters affect the VCO Power Output:

B.1. SUPPLY CURRENT

- Increasing supply current typically increases power output.

B.2. PULLING

- To improve pulling, output power should be reduced by connecting an attenuation circuit at the VCO output.
- Improved pulling can also be achieved by connecting a buffer amplifier at the VCO output port. However, this buffer amplifier requires a higher supply current.

B.3. TEMPERATURE.

- From an ambient temp of +25°C: a temp increase to +85°C results in an output power decrease of 0.5dB to 1.0dB typically.
- From an ambient temp of +25°C: a temp decrease to -55°C results in an output power increase of 0.5dB to 1.0dB typically.

(NOTE: Definitions of VCO terms appear on Pages 40-41)

C. Parameters Affecting VCO's Power Output Flatness

The following parameters affect the VCO Power Output Flatness:

C.1. FREQUENCY BANDWIDTH
- As the VCO frequency range is increased, the difficulty to achieve a flat output power is increased.

C.2. TUNING VOLTAGE
- As the tuning voltage range is reduced and narrowed, a flatter output power can be achieved.

C.3. TUNING SENSITIVITY
- It is more difficult to achieve flat output power for high tuning sensitivity than for low tuning sensitivity.

C.4. HARMONICS
- Adding an output filter to suppress harmonics may in some cases degrade power output flatness.

D. Parameters Affecting VCO Tuning Sensitivity

The following parameters affect the VCO Tuning Sensitivity:

D.1. FREQUENCY RANGE
- For a given tuning voltage range, increasing the frequency range requires an increase in the tuning sensitivity, and vice-versa.

D.2. TUNING VOLTAGE
- For a given frequency range, increasing the tuning voltage range decreases the tuning sensitivity, and vice-versa.

E. Parameters Affecting VCO Supply Current

The following parameters affect the VCO Supply Current:

E.1. POWER OUTPUT
- Increasing power output requires higher supply current.

E.2. PULLING
Same As B.2.

E.3. TEMPERATURE
- From an ambient temp of +25°C: a temp increase to +85°C typically results in a supply current increase of approximately 10%.
- From an ambient temp of +25°C: a temp decrease to -55°C typically results in a supply current decrease of approximately 10%.

F. Parameters Affecting VCO Pushing

The following parameters affect the VCO Pushing:

F.1. FREQUENCY
- As the VCO frequency increases, difficulty in achieving good pushing is increased.

F.2. POWER SUPPLY
- Good pushing is easier to achieve in designs with high current.

G. Parameters Affecting VCO Pulling

The following parameters affect the VCO Pulling:

G.1. FREQUENCY
- As the VCO frequency increases, difficulty in achieving good pulling is increased.
- See B.2.

G.2. SUPPLY CURRENT
- It is difficult to achieve good pulling when there is a limit on supply current consumption, due to the fact that (connecting a buffer amplifier at the VCO output port) improving pulling increases current consumption.

H. Parameters Affecting VCO Modulation Bandwidth

The following parameters affect the VCO Modulation Bandwidth:

H.1. FREQUENCY
- Higher modulation bandwidth can easily be achieved at higher frequency.

I. Parameters Affecting VCO Harmonics Suppression

The following parameters affect VCO Harmonics Suppression:

I.1. FREQUENCY BANDWIDTH
- It is easier to achieve good harmonics suppression when frequency range is narrow.

I.2. TEMPERATURE
- With ambient temperature increase, the harmonic level gets lower. With ambient temperature decrease, the harmonic level gets higher.

J. Parameters Affecting VCO Phase Noise

The following parameters affect VCO Phase Noise:

J.1. FREQUENCY
- As carrier frequency increases, it's more difficult to achieve good phase noise.

J.2. FREQUENCY RANGE
- It's easy to achieve good phase noise when frequency range is narrow.

J.3. TUNING SENSITIVITY
- Increasing the tuning sensitivity degrades phase noise and vice-versa.

J.4. SUPPLY CURRENT
- It is typically easy to achieve good phase noise at higher offset frequencies (> 1kHz) in designs with a high supply current.

J.5. TUNING VOLTAGE
- For a given frequency range it is typically easy to achieve good phase noise in designs with a wide tuning voltage range.

J.6. TEMPERATURE
- Phase noise varies typically by 3dB in the –55°C to +85°C range.

J.7. PUSHING
- High pushing can cause phase noise degradation due to increased sensitivity to the power supply noise.

Typical values of narrow band VCOs are shown in the table below:

PHASE NOISE (-dBc/HZ)	FREQUENCY (GHz)
115÷120	<0.5
110÷115	0.5÷1
102÷110	1÷2
95÷102	2÷3

VCO Selection Guide

		MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3 dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CASE STYLE See pgs. 112-113	CONNECTION
Octave Band	Shielded Plug-In LINEAR TUNING	POS-25	15	25	+7.0	1.0	11	-86	-105	-125	-145	0.06	0.04	1-4	-26	-15	60	12	20	A06	hx
		POS-50	25	50	+8.5	1.0	16	-88	-110	-130	-150	0.06	0.04	2.0-2.6	-19	-12	100	12	20	A06	hx
		POS-75	37.5	75	+8.0	1.0	16	-87	-110	-130	-150	0.15	0.11	3.1-3.8	-27	-16	100	12	20	A06	hx
		POS-100	50	100	+8.3	1.0	16	-83	-107	-130	-150	0.6	0.2	4.2-4.8	-23	-18	100	12	20	A06	hx
		POS-150	75	150	+9.5	1.0	16	-80	-103	-127	-147	0.8	0.3	5.8-6.7	-23	-17	100	12	20	A06	hx
		POS-200	100	200	+10.0	1.0	16	-80	-102	-122	-142	1.0	0.2	7.1-8.6	-24	-20	100	12	20	A06	hx
		POS-300	150	280	+10.0	1.0	16	-78	-100	-120	-140	1.8	0.3	9.5-13	-30	-20	100	12	20	A06	hx
		POS-400	200	380	+9.5	1.0	16	-76	-98	-120	-140	1.8	0.3	13.7-16.9	-28	-20	100	12	20	A06	hx
		POS-535	300	525	+8.8	1.0	16	-70	-93	-116	-139	2.0	0.4	10.5-24	-26	-20	100	12	20	A06	hx
		POS-765	485	765	+9.5	1.0	16	-61	-85	-108	-129	5.0	0.4	18-27	-21	-17	100	12	22	A06	hx
		POS-1025	685	1025	+9.0	1.0	16	-65	-84	-104	-124	5.0	0.6	21-36	-23	-18	100	12	22	A06	hx
		POS-1060	750	1060	+12.0	1.0	20	-65	-90	-112	-132	50.0	3.0	18-32	-11	--	1000	8	30	A06	hx
		POS-1400A	975	1400	+13.0	1.0	20	-65	-95	-115	-135	14.0	2.0	25-30	-16	--	4000	8	30	A06	hx
		POS-2000A	1370	2000	+11.6	1.0	20	-73	-97	-117	-137	12.0	3.0	30-45	-24	-12	4000	8	30	A06	hx
		POS-500W	250	500	+10.0	1.0	16	-79	-100	-120	-140	1.5	0.2	17-23	-25	-18	100	12	25	A06	hx
		POS-800W	400	800	+8.0	0.5	18	-71	-93	-115	-137	3.0	0.5	18-50	-26	-18	100	10	25	A06	hx
		POS-900W	500	900	+7.0	1.0	20	-75	-95	-115	-135	2.0	0.3	16-40	-26	-20	100	12	25	A06	hx
		POS-1000W	500	1000	+7.0	1.0	16	-73	-93	-113	-133	6.0	1.5	30-42	-26	-20	100	12	20	A06	hx
		POS-2120W	1060	2120	+8.0	0.5	20	-70	-97	-117	-137	27.0	2.5	35-120	-11	--	1000	12	28	A06	hx
	Surface Mount LINEAR TUNING	JTOS-25	12.5	25	+8.0	1.0	11	-95	-115	-135	-155	0.03	0.02	1.0-4.0	-26	-13	130	12	20	BK377	jc
		JTOS-50	25	47	+8.5	1.0	15	-88	-108	-127	-147	0.06	0.04	2.0-2.6	-19	-12	50	12	20	BK377	jc
		JTOS-75	37.5	75	+8.0	1.0	16	-89	-110	-130	-140	0.15	0.11	2.8-4.0	-27	-20	125	12	20	BK377	jc
		JTOS-100	50	100	+8.3	1.0	16	-83	-108	-128	-140	0.6	0.2	3.7-4.8	-35	-20	100	12	18	BK377	jc
		JTOS-150	75	150	+9.5	1.0	16	-82	-106	-127	-147	0.8	0.3	5.8-6.7	-23	-17	112	12	20	BK377	jc
		JTOS-200	100	200	+10.0	1.0	16	-84	-105	-124	-145	1.0	0.2	6-10	-25	-20	110	12	20	BK377	jc
		JTOS-300	150	280	+9.0	1.0	16	-82	-102	-122	-142	1.0	0.2	9-14	-28	-20	120	12	20	BK377	jc
		JTOS-400	200	380	+9.0	1.0	16	-82	-102	-122	-142	1.4	0.4	10.5-17.1	-25	-20	130	12	20	BK377	jc
		JTOS-535	300	525	+9.5	1.0	16	-75	-97	-117	-137	2.0	0.5	10-24	-28	-20	115	12	20	BK377	jc
		JTOS-765	485	765	+8.0	1.0	16	-75	-98	-118	-138	2.0	0.5	20-30	-30	-20	100	12	20	BK377	jc
		JTOS-1025	685	1025	+8.6	1.0	16	-70	-94	-114	-134	5.0	0.6	21-36	-28	-20	100	12	22	BK377	jc
		JTOS-1300	900	1300	+7.0	1.0	20	-70	-95	-115	-135	12.0	1.0	25-45	-28	-17	1000	12	30	BK377	jc
		JTOS-1550	1150	1550	+7.0	0.5	20	-73	-101	-121	-141	14.0	0.7	22-32	-20	-10	2700	12	30	BK377	jc
		JTOS-1650	1200	1650	+7.0	1.0	13	-70	-95	-115	-135	15.0	1.5	50-90	-20	-14	1000	12	30	BK377	jc
		JTOS-1750	1350	1750	+7.0	0.5	20	-73	-101	-121	-141	7.0	0.5	26-35	-16	-10	2700	12	30	BK377	jc
		JTOS-1910	1625	1910	+7.0	1.0	12	-69	-97	-117	-137	10.0	1.0	30-60	-20	-15	2500	12	20	BK377	jc
		JTOS-1950	1550	1950	+7.0	0.5	20	-75	-103	-125	-144	7.0	0.6	23-32	-14	-10	8000	12	30	BK377	jc
		JTOS-2000	1370	2000	+12.0	1.0	22	-70	-95	-115	-135	40.0	1.5	30-50	-11	-8	1000	8	30	BK377	jc
		JTOS-2700V	2050	2700	+8.0	0.5	18	-72	-94	-114	-134	5.0	1.0	46-56	-25	-10	8000	5	20	BK377	jc
		JTOS-3000	2300	3000	+10.0	0.5	12	-60	-90	-110	-130	50.0	5.0	50-150	-22	-12	20000	5	25	BK377	jc
		ROS-100	50	100	+8.3	0.5	17	-75	-105	-125	-145	0.6	0.3	3.0-5.0	-30	-20	100	12	20	CK605	kg
		ROS-150	75	150	+9.5	1.0	18	-80	-103	-127	-144	0.8	0.3	4.0-6.8	-23	-16	100	12	20	CK605	kg
		ROS-200	100	200	+10.0	1.0	17	-80	-105	-125	-145	0.6	0.3	6-11	-30	-20	100	12	20	CK605	kg
		ROS-300	150	280	+9.0	1.0	16	-80	-102	-122	-142	0.5	0.3	7-17	-28	-18	100	12	20	CK605	kg
		ROS-400	200	380	+9.5	0.5	17	-80	-100	-120	-140	0.2	0.3	9-22	-24	-18	100	12	20	CK605	kg
		ROS-535	300	525	+6.0	1.0	17	-75	-98	-118	-138	0.5	0.4	9-27	-20	-15	100	12	20	CK605	kg
		ROS-765	485	765	+6.0	1.0	16	-74	-95	-115	-135	2.0	0.5	10-40	-27	-14	100	12	22	CK605	kg
		ROS-1000V	900	1000	+0.0	0.5	12	-74	-102	-122	-140	1.0	0.4	12-16	-30	-20	8000	5	25	CK605	kg
		ROS-1100V	1000	1100	+0.0	0.5	12	-80	-103	-123	-142	1.5	1.5	12-16	-26	-20	8000	5	25	CK605	kg
		ROS-1121V	1060	1121	+2.5	1.0	11	-88	-111	-131	-149	0.7	0.7	8-13	-11	--	10000	5	30	CK605	kg
		ROS-1410	850	1410	+7.0	0.5	11	-73	-99	-119	-138	15.0	1.0	50-80	-8	--	1000	12	25	CK605	kg
		ROS-1500	1000	1500	+5.0	0.5	20	-79	-104	-124	-144	10.0	1.2	16-40	-13	--	100000	12	26	CK605	kg
		ROS-1720	1500	1720	+7.0	0.5	12	-73	-101	-121	-141	11.0	1.3	28-34	-17	-10	18000	12	25	CK605	kg
		ROS-1900	1450	1900	+7.0	0.5	20	-80	-106	-126	-146	7.0	0.7	22-34	-15	-10	100000	10	25	CK605	kg
		ROS-1900V	1450	1900	+8.0	0.5	20	-78	-104	-124	-144	7.0	0.7	22-34	-18	-10	100000	5	28	CK605	kg
		ROS-2000	1350	2000	+7.0	0.5	20	-75	-100	-120	-140	8.0	1.5	30-50	-11	--	2000	12	26	CK605	kg
		ROS-2500	1600	2500	+6.5	0.5	14	-66	-90	-113	-133	18.0	5.0	30-180	-14	-8	6000	12	25	CK605	kg
		ROS-2650	2165	2650	+6.0	0.5	10	-75	-101	-121	-141	8.0	1.0	27-36	-12	--	6000	12	25	CK605	kg
		ROS-3000V	2400	3000	+9.0	0.5	22	-70	-96	-116	-136	30.0	1.5	20-60	-18	--	20000	5	40	CK605	kg
Octave Band		JTOS-850VW	400	850	+8.0	0.5	18	-74	-96	-116	-136	6.0	1.6	15-80	-20	--	185	5	20	BK377	jc
		JTOS-1000W	500	1000	+7.0	1.0	18	-73	-94	-114	-134	5.0	1.0	30-40	-26	-20	100	12	25	BK377	jc
		ROS-1200W	612	1200	+10.0	0.5	18	-71	-97	-119	-139	9.0	0.45	26-68	-28	-10	20000	12	40	CK605	kg
		ROS-1700W	770	1700	+8.0	1.0	24	-73	-100	-121	-140	9.0	0.4	26-60	-25	-13	7000	12	40	CK605	kg
		ROS-2150VW	970	2150	+4.0	0.5	25	-70	-96	-118	-138	7.0	2.5	30-70	-15	--	6000	5	25	CK605	kg
		ROS-2160W	1160	2160	+5.0	0.5	20	-70	-97	-117	-137	10.0	1.5	30-80	-11	--	12000	10	30	CK605	kg

	MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1kHz	10kHz	100kHz	1MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3 dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CASE STYLE See pgs. 112-113	CONNECTION
Surface Mount 5V TUNING FOR PLL ICs	JTOS-50P	24-29		+9.5	-88	-108	-127	-147	0.06	0.04	2-2.5	-14	-12	50	12	20	BK377	jc
	JTOS-75P	35-43		+9.0	-89	-110	-130	-140	0.15	0.11	2.5-4	-25	-20	125	12	20	BK377	jc
	JTOS-100P	48-59		+9.0	-83	-108	-128	-140	0.6	0.2	3.5-4	-30	-20	100	12	18	BK377	jc
	JTOS-150P	72-91		+9.5	-82	-106	-127	-147	0.8	0.3	6-9	-30	-17	112	12	20	BK377	jc
	JTOS-200P	95-120		+8.8	-84	-105	-124	-145	1.0	0.2	7-10	-30	-20	110	12	20	BK377	jc
	JTOS-300P	148-174		+10.0	-82	-102	-122	-142	1.0	0.2	10-14	-27	-20	120	12	20	BK377	jc
	JTOS-400P	194-220		+11.0	-82	-102	-122	-142	1.4	0.4	13-18	-25	-20	130	12	20	BK377	jc
	JTOS-535P	278-325		+9.5	-75	-97	-117	-137	2.0	0.5	17-22	-30	-20	115	12	20	BK377	jc
	JTOS-765P	486-510		+9.0	-75	-98	-118	-138	2.0	0.5	20-30	-30	-20	100	12	20	BK377	jc
	JTOS-1025P	680-775		+9.0	-70	-94	-114	-134	5.0	0.6	30-40	-27	-20	100	12	22	BK377	jc
	JTOS-2200PA	2000-2200		+6.0	-65	-92	-112	-132	15.0	5.0	110-170	-22	-12	10000	5	25	BK377	jc
	JTOS-3000P	2300-2600		+11.0	-65	-92	-112	-132	50.0	5.0	120-160	-22	-12	20000	5	25	BK377	jc
	MOS-1826PV	1760-1826		+2.0	-75	-101	-122	-142	8.0	1.0	21-35	-28	-15	10000	5	25	CZ682	my
	ROS-205PV	180-210		+2.0	-88	-110	-131	-151	0.4	0.4	10-15	-30	-20	2000	5	15	CK605	kg
	ROS-285PV	245-285		+3.0	-80	-100	-120	-140	2.0	0.2	10-20	-20	-10	100	5	20	CK605	kg
	ROS-550PV	450-550		+6.0	-81	-104	-124	-144	3.0	0.5	30-60	-15	--	8000	6	16	CK605	kg
	ROS-660PV	640-660		+0.0	-85	-107	-127	-147	0.8	0.6	10-14	-17	-12	2000	5	15	CK605	kg
	ROS-675PV	655-675		+0.0	-86	-107	-127	-146	1.0	0.5	10-14	-23	-10	5000	6	15	CK605	kg
	ROS-725PV	710-725		+0.0	-85	-105	-126	-145	0.9	0.3	8-13	-19	-12	2000	5	15	CK605	kg
	ROS-740PV	720-740		+0.0	-84	-106	-126	-145	1.0	0.8	10-14	-16	-10	5000	5	15	CK605	kg
	ROS-900PV	810-900		+1.0	-80	-102	-122	-142	3.0	2.0	26-30	-25	-16	1000	4.5	12	CK605	kg
	ROS-960PV	890-960		+0.0	-80	-102	-122	-142	2.0	0.2	25-28	-27	-18	1000	5	12	CK605	kg
	ROS-1000PV	900-1000		+6.0	-80	-104	-124	-144	2.0	0.7	27-38	-33	-20	1000	5	22	CK605	kg
	ROS-1435PV	1375-1435		+3.0	-78	-101	-121	-141	4.0	1.7	20-30	-26	-18	5000	5	20	CK605	kg
	ROS-1600PV	1520-1600		+7.0	-75	-100	-120	-140	10.0	3.0	25-38	-26	-16	1000	5	25	CK605	kg
	ROS-1605PV	1500-1605		+0.0	-74	-98	-118	-138	6.0	0.8	40-50	-17	-8	8000	3.3	16	CK605	kg
Shielded Plug-In	POS-50P	24-29		+10.0	-92	-113	-134	-151	0.06	0.04	2-2.5	-18	-12	50	12	20	A06	hx
	POS-75P	35-43		+9.0	-91	-113	-135	-151	0.15	0.11	2.5-4	-25	-20	100	12	20	A06	hx
	POS-100P	48-59		+9.0	-92	-112	-134	-151	0.6	0.2	3.5-5	-30	-18	100	12	20	A06	hx
	POS-150P	72-91		+10.0	-84	-104	-126	-147	0.8	0.3	6-9	-25	-17	100	12	20	A06	hx
	POS-200P	95-120		+10.0	-77	-102	-123	-146	1.0	0.2	7-10	-30	-20	100	12	20	A06	hx
	POS-300P	148-174		+10.0	-83	-105	-125	-145	1.8	0.3	10-14	-27	-20	100	12	20	A06	hx
	POS-400P	194-220		+10.5	-82	-103	-124	-142	1.8	0.3	13-18	-25	-20	100	12	20	A06	hx
	POS-535P	278-325		+10.0	-66	-95	-120	-138	2.0	0.4	17-22	-30	-20	100	12	20	A06	hx
	POS-765P	486-510		+9.5	-70	-92	-116	-135	5.0	0.4	20-30	-26	-20	100	12	22	A06	hx
	POS-1025P	680-755		+8.5	-74	-96	-116	-135	5.0	0.6	30-40	-24	-18	100	12	22	A06	hx
Surface Mount LOW NOISE	JCOS-820WLN	780-860		+9.0	-90	-112	-132	-150	4.5	0.3	8	-13	-8	2000	9	25	BG419	jd
	JCOS-820BLN	807-832		+3.0	-88	-112	-132	-151	0.4	0.4	6	-24	-20	2000	10	25	BG419	jd
	JCOS-175LN	125-175		+3.7	-95	-118	-138	-158	0.08	0.05	3.5	-25	-20	2900	12	20	BG419	jd
	JCOS-1100LN	1079-1114		+8.5	-88	-110	-130	-150	7.5	0.5	4.5	-15	-20	2000	8	25	BG419	jd
	ROS-810LN	760-810		+5.0	-90	-115	-135	-155	1.8	0.5	8-10	-24	-18	6000	8	20	CK605	kg
Shielded Plug-In LOW NOISE	POSA-138	118-138		+5.0	-100	-125	-145	-163	0.07	0.03	2.3	-40	-30	2000	12	25	C07	jr
	POSA-158	138-158		+5.0	-100	-125	-145	-163	0.07	0.03	2.4	-40	-25	2000	12	25	C07	jr
	POSA-960	800-960		+16.0	-84	-112	-130	-150	2.0	0.3	17-22	-30	-16	2000	15	50	C07	mj
SMA Female Coaxial DUAL OUTPUT	ZOS-50	25-50		+9.0	-	-107	-126	-141	0.012	0.08	2.5	-22	-12	100	12	140	BR386	-
	ZOS-75	37.5-75		+9.0	-	-110	-128	-142	0.016	0.15	3.5	-26	-20	100	12	140	BR386	-
	ZOS-100	50-100		+9.0	-	-111	-131	-143	0.026	0.25	4.5	-29	-20	100	12	140	BR386	-
	ZOS-150	75-150		+9.0	-	-107	-127	-142	0.017	0.39	5.8	-23	-17	100	12	140	BR386	-
	ZOS-200	100-200		+10.0	-	-106	-126	-141	0.015	0.42	7.7	-25	-20	100	12	140	BR386	-
	ZOS-300	150-280		+9.0	-	-103	-123	-142	0.017	0.50	11	-27	-20	100	12	140	BR386	-
	ZOS-400	200-380		+10.0	-	-100	-120	-136	0.021	0.50	15	-24	-18	100	12	140	BR386	-
	ZOS-535	300-525		+9.0	-	-96	-118	-131	0.018	0.50	18	-27	-20	100	12	140	BR386	-
	ZOS-765	485-765		+8.5	-	-96	-117	-132	0.033	0.72	22	-27	-17	100	12	140	BR386	-
	ZOS-1025	685-1025		+8.0	-	-92	-112	-136	0.051	1.00	30	-25	-18	100	12	140	BR386	-

NOTES:

ZOS: MAIN POWER OUTPUT SPECIFIED.

TUNING VOLTAGE TO COVER FREQUENCY RANGE:

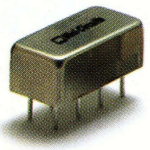
Min. Max.

0.5V to 5V: JTOS (P, PA), MOS, ROS (PV), POS (P)
0.5V to 10V: ROS-810LN
1V to 16V: ZOS, POSA-138, -158
0V to 20V: JCOS-820WLN, -1100LN
1V to 14V: JCOS-820BLN
1V to 17V: JCOS-175LN
1V to 15V: POSA-960

VOLTAGE CONTROLLED OSCILLATORS

LINEAR TUNING *PLUG-IN*

WIDE BAND *15 to 2000Hz*



MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	(HARMONICS (dBc) Typ.	Max.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
POS-25	15	25	+7.0	1	11	-86	-105	-125	-145	0.06	0.04	1-4	-26	-15	60	12	20	48	A06	hx	16.95
POS-50	25	50	+8.5	1	16	-88	-110	-130	-150	0.06	0.04	2.0-2.6	-19	-12	100	12	20	48	A06	hx	11.95
POS-75	37.5	75	+8.0	1	16	-87	-110	-130	-150	0.15	0.11	3.1-3.8	-27	-16	100	12	20	49	A06	hx	11.95
POS-100	50	100	+8.3	1	16	-83	-107	-130	-150	0.6	0.2	4.2-4.8	-23	-18	100	12	20	49	A06	hx	11.95
POS-150	75	150	+9.5	1	16	-80	-103	-127	-147	0.8	0.3	5.8-6.7	-23	-17	100	12	20	50	A06	hx	11.95
POS-200	100	200	+10.0	1	16	-80	-102	-122	-142	1.0	0.2	7.1-8.6	-24	-20	100	12	20	50	A06	hx	11.95
POS-300	150	280	+10.0	1	16	-78	-100	-120	-140	1.8	0.3	9.5-13	-30	-20	100	12	20	51	A06	hx	13.95
POS-400	200	380	+9.5	1	16	-76	-98	-120	-140	1.8	0.3	13.7-16.9	-28	-20	100	12	20	51	A06	hx	13.95
POS-535	300	525	+8.8	1	16	-70	-93	-116	-139	2.0	0.4	10.5-24	-26	-20	100	12	20	52	A06	hx	13.95
POS-765	485	765	+9.5	1	16	-61	-85	-108	-129	5.0	0.4	18-27	-21	-17	100	12	22	52	A06	hx	14.95
POS-1025	685	1025	+9.0	1	16	-65	-84	-104	-124	5.0	0.6	21-36	-23	-18	100	12	22	53	A06	hx	16.95
POS-1060	750	1060	+12.0	1	20	-65	-90	-112	-132	50	3.0	18-32	-11	--	1000	8	30	53	A06	hx	14.95
POS-1400A	975	1400	+13.0	1	20	-65	-95	-115	-135	14	2.0	25-30	-16	--	4000	8	30	54	A06	hx	14.95
POS-2000A	1370	2000	+11.6	1	20	-73	-97	-117	-137	12	3.0	30-45	-24	-12	4000	8	30	54	A06	hx	14.95

NOTES:

A. General Quality Control Procedures, Environmental specifications, Hi-Rel, and MIL description are given in Mini-Circuits RF/IF Designer's Guide.

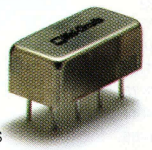
B. Connector types, case mounted options, and case finishes are given with "Outline Drawings & Case Style Dimensions" on pages 112 and 113.

C. Prices and Specifications subject to change without notice.
1. Absolute Maximum Supply Voltage (V_{cc}) & Tuning Voltage (V_{tune}):
2. Operating Temperature: -55°C to +85°C

Model	(V_{cc})	(V_{tune})	Model	(V_{cc})	(V_{tune})
POS-25	+15V	+12V	POS-400	+16V	+18V
POS-50	+16V	+17V	POS-535	+16V	+18V
POS-75	+16V	+18V	POS-765	+16V	+18V
POS-100	+16V	+18V	POS-1025	+16V	+18V
POS-150	+16V	+18V	POS-1060	+10V	+22V
POS-200	+16V	+18V	POS-1400A	+10V	+25V
POS-300	+16V	+18V	POS-2000A	+10V	+25V

PIN CONNECTIONS
see case style and outline drawings

PORT	hx
RF OUT	2
V-CC	1
V-TUNE	8
GND EXT	3,4,5,6,7



OCTAVE BAND 250 to 2120 MHz POS

MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3 dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
POS-500W	250-500		+10.0	1	16	-79	-100	-120	-140	1.5	0.2	17-23	-25	-18	100	12	25	55	A06	hx	18.95
POS-800W	400-800		+8.0	.5	18	-71	-93	-115	-137	3.0	0.5	18-50	-26	-18	100	10	25	55	A06	hx	16.95
POS-900W	500-900		+7.0	1	20	-75	-95	-115	-135	2.0	0.3	16-40	-26	-20	100	12	25	56	A06	hx	16.95
POS-1000W	500-1000		+7.0	1	16	-73	-93	-113	-133	6.0	1.5	30-42	-26	-20	100	12	20	56	A06	hx	19.95
POS-2120W	1060-2120		+8.0	.5	20	-70	-97	-117	-137	27	2.5	35-120	-11	--	1000	12	28	57	A06	hx	21.95

FEATURES

- Octave bandwidth range (typ.)
- Linear tuning
- Low phase noise
- Excellent harmonic suppression
- Output suitable for LO drive to mixers
- 12-V parts are usable with +15V supply for higher power output, typically 2dB
- Useful in digital cordless phones, cellular up-and-down converters, CATV distribution and set top converters, wideband frequency synthesizers, test instruments, signal generators and agile communications systems

Absolute max. rating for V_{cc} and V_{tune}

Model	(V_{CC})	(V_{tune})
POS-500W	+15V	+20V
POS-800W	+12V	+20V
POS-900W	+15V	+25V
POS-1000W	+15V	+20V
POS-2120W	+15V	+25V

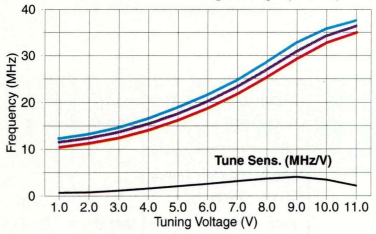
DESIGNERS KITS AVAILABLE

KIT No.	Units Per Kit	Description	Price $ Per Kit
K-POS1	10	1 of each: POS-50, 75, 100, 150, 200, 300, 400, 535, 765, 1025	124.95
K-POS2	7	1 of each: POS-50, 100, 200, 400, 535, 765, 1025	79.95
K-POS3	6	2 of each: POS-1060, 1400A, 2000A	79.95

POS-25

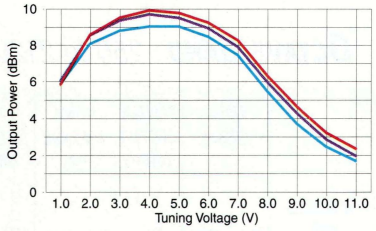
Linear Tuning - spec pg. 46

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

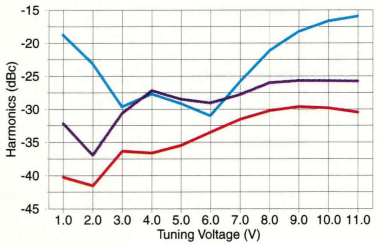


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	0.71	11.10	10.89	10.75	5.86	6.18	5.83
2.0	0.81	12.04	11.75	11.59	8.04	8.67	8.57
3.0	1.15	13.42	13.01	12.78	8.77	9.49	9.52
4.0	1.63	15.34	14.75	14.44	9.01	9.83	9.91
5.0	2.12	17.68	16.93	16.56	9.01	9.63	9.77
6.0	2.58	20.36	19.55	19.10	8.45	9.07	9.24
7.0	3.13	23.51	22.67	22.15	7.43	8.03	8.26
8.0	3.72	27.36	26.32	25.75	5.46	6.09	6.32
9.0	4.07	31.53	30.25	29.67	3.69	4.42	4.64
10.0	3.48	34.59	33.61	33.09	2.45	2.99	3.22
11.0	2.21	36.37	35.74	35.30	1.67	2.10	2.35

Power Output



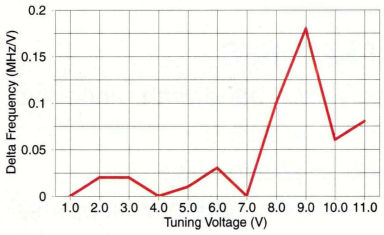
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-18.88	-32.27	-40.34	0.00
2.0	-23.24	-37.04	-41.63	0.02
3.0	-29.76	-30.70	-36.42	0.02
4.0	-27.81	-27.25	-36.68	0.00
5.0	-29.26	-28.58	-35.54	0.01
6.0	-31.13	-29.18	-33.56	0.03
7.0	-25.97	-27.89	-31.63	0.00
8.0	-21.31	-26.08	-30.32	0.10
9.0	-18.38	-25.78	-29.70	0.18
10.0	-16.78	-25.79	-29.88	0.06
11.0	-16.06	-25.86	-30.56	0.08

Frequency Pushing

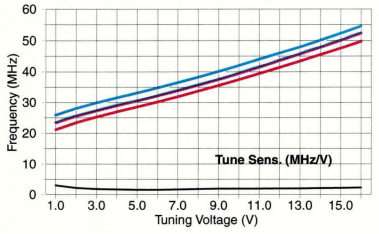
(Supply Voltage 12V)



POS-50

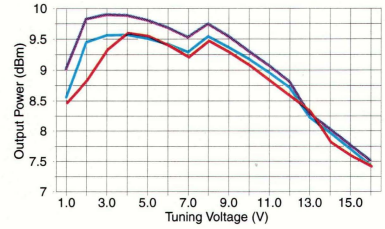
Linear Tuning - spec pg. 46

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

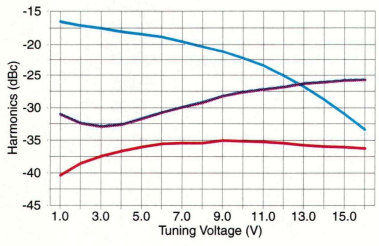


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	3.00	23.19	23.04	22.69	8.57	8.97	8.51
2.0	2.20	25.37	25.21	24.87	9.46	9.78	8.88
3.0	1.80	27.13	27.04	26.74	9.57	9.85	9.37
4.0	1.70	28.75	28.70	28.42	9.58	9.84	9.64
5.0	1.60	30.35	30.31	30.05	9.52	9.76	9.59
6.0	1.60	31.99	31.96	31.70	9.43	9.64	9.44
7.0	1.70	33.70	33.67	33.42	9.30	9.48	9.25
8.0	1.80	35.49	35.45	35.22	9.55	9.70	9.51
9.0	1.90	37.35	37.30	37.08	9.38	9.50	9.33
10.0	1.90	39.29	39.21	39.00	9.19	9.26	9.12
11.0	1.90	41.31	41.15	40.94	8.97	9.03	8.87
12.0	2.00	43.39	43.12	42.90	8.73	8.77	8.62
13.0	2.00	45.52	45.16	44.91	8.24	8.25	8.37
14.0	2.10	47.69	47.29	46.99	7.98	7.99	7.86
15.0	2.20	49.91	49.47	49.13	7.72	7.73	7.64
16.0	2.30	52.17	51.72	51.27	7.45	7.47	7.46

Power Output



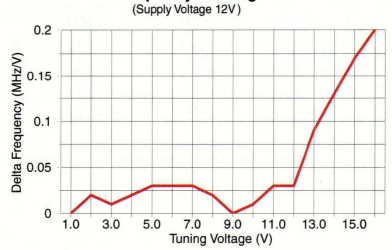
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-16.70	-31.10	-40.40	0.00
2.0	-17.30	-32.50	-38.60	0.02
3.0	-17.70	-33.00	-37.50	0.01
4.0	-18.20	-32.70	-36.70	0.02
5.0	-18.60	-31.80	-36.10	0.03
6.0	-19.00	-30.80	-35.60	0.03
7.0	-19.70	-30.00	-35.50	0.03
8.0	-20.50	-29.30	-35.50	0.02
9.0	-21.30	-28.30	-35.10	0.00
10.0	-22.40	-27.70	-35.20	0.01
11.0	-23.60	-27.30	-35.30	0.03
12.0	-25.20	-26.90	-35.50	0.03
13.0	-26.90	-26.40	-35.80	0.09
14.0	-28.90	-26.20	-36.00	0.13
15.0	-31.10	-25.90	-36.10	0.17
16.0	-33.50	-25.80	-36.30	0.20

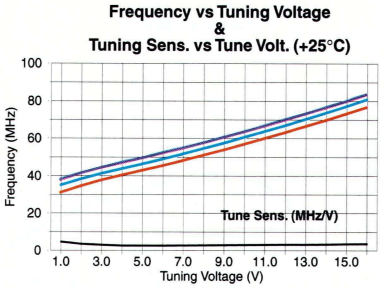
Frequency Pushing

(Supply Voltage 12V)

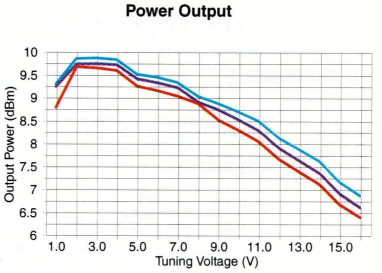


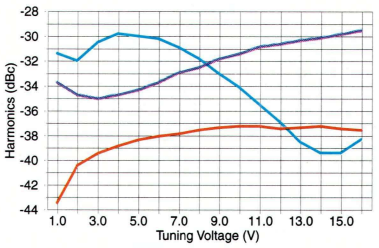
POS-75

Linear Tuning - spec pg. 46

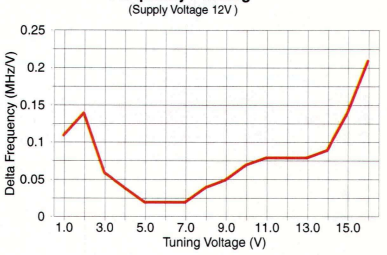


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	4.70	35.61	35.31	34.79	9.25	9.26	8.81
2.0	3.50	39.02	38.81	38.32	9.81	9.75	9.70
3.0	3.00	41.88	41.78	41.34	9.82	9.76	9.67
4.0	2.60	44.50	44.42	44.02	9.79	9.74	9.62
5.0	2.60	47.08	46.98	46.59	9.47	9.43	9.28
6.0	2.60	49.71	49.58	49.20	9.40	9.35	9.18
7.0	2.70	52.45	52.27	51.89	9.29	9.24	9.06
8.0	2.80	55.32	55.08	54.70	8.99	8.93	8.90
9.0	2.90	58.30	58.00	57.63	8.83	8.76	8.54
10.0	3.00	61.35	61.02	60.66	8.65	8.54	8.32
11.0	3.10	64.47	64.12	63.77	8.45	8.31	8.07
12.0	3.20	67.68	67.28	66.94	8.08	7.92	7.68
13.0	3.20	70.98	70.52	70.18	7.83	7.65	7.41
14.0	3.30	74.40	73.86	73.51	7.57	7.37	7.13
15.0	3.50	77.95	77.34	76.95	7.12	6.93	6.70
16.0	3.60	81.65	80.98	80.55	6.82	6.63	6.42



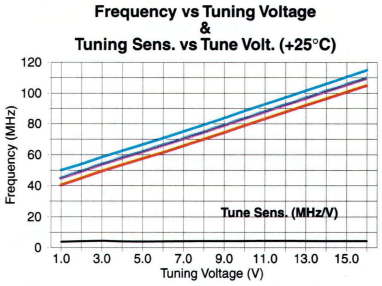


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-31.40	-33.70	-43.40	0.11
2.0	-32.00	-34.70	-40.40	0.14
3.0	-30.50	-35.00	-39.40	0.06
4.0	-29.80	-34.70	-38.80	0.04
5.0	-30.00	-34.30	-38.30	0.02
6.0	-30.20	-33.70	-38.00	0.02
7.0	-30.90	-32.90	-37.80	0.02
8.0	-31.80	-32.50	-37.50	0.04
9.0	-33.00	-31.80	-37.30	0.05
10.0	-34.10	-31.40	-37.20	0.07
11.0	-35.50	-30.80	-37.20	0.08
12.0	-36.90	-30.60	-37.40	0.08
13.0	-38.50	-30.30	-37.30	0.08
14.0	-39.40	-30.10	-37.20	0.09
15.0	-39.40	-29.80	-37.40	0.14
16.0	-38.30	-29.50	-37.50	0.21

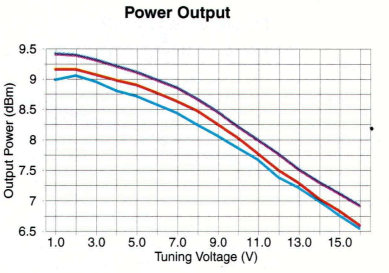


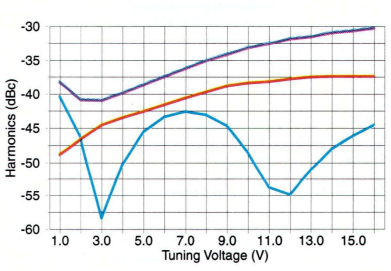
POS-100

Linear Tuning - spec pg. 46

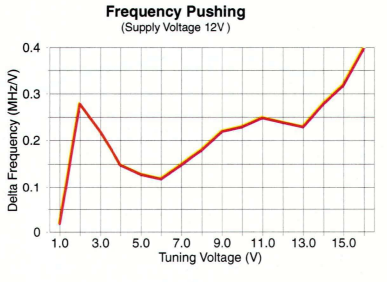


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	3.80	45.55	44.40	43.93	8.98	9.42	9.17
2.0	4.20	49.41	48.60	48.31	9.05	9.40	9.17
3.0	4.50	53.98	53.15	52.83	8.95	9.32	9.08
4.0	4.10	58.08	57.27	56.90	8.80	9.22	8.99
5.0	4.00	62.10	61.31	60.88	8.71	9.12	8.91
6.0	4.10	66.20	65.43	64.96	8.57	8.99	8.78
7.0	4.20	70.43	69.62	69.13	8.43	8.86	8.64
8.0	4.30	74.80	73.93	73.43	8.24	8.67	8.48
9.0	4.40	79.26	78.33	77.81	8.06	8.46	8.26
10.0	4.40	83.78	82.77	82.25	7.86	8.22	8.04
11.0	4.50	88.26	87.23	86.68	7.67	8.00	7.78
12.0	4.50	92.73	91.69	91.10	7.38	7.77	7.51
13.0	4.40	97.13	96.06	95.46	7.21	7.52	7.30
14.0	4.40	101.53	100.45	99.81	6.99	7.31	7.04
15.0	4.40	105.98	104.84	104.18	6.76	7.13	6.85
16.0	4.40	110.43	109.22	108.55	6.54	6.93	6.61





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-40.40	-38.20	-48.70	0.02
2.0	-46.40	-40.80	-46.60	0.28
3.0	-58.40	-40.90	-44.50	0.22
4.0	-50.30	-39.80	-43.40	0.15
5.0	-45.60	-38.60	-42.50	0.13
6.0	-43.40	-37.40	-41.50	0.12
7.0	-42.60	-36.20	-40.50	0.15
8.0	-43.10	-35.00	-39.60	0.18
9.0	-44.70	-34.10	-38.70	0.22
10.0	-48.50	-33.10	-38.30	0.23
11.0	-53.80	-32.50	-38.10	0.25
12.0	-54.90	-31.80	-37.70	0.24
13.0	-51.10	-31.50	-37.40	0.23
14.0	-48.00	-30.90	-37.30	0.28
15.0	-46.20	-30.60	-37.30	0.32
16.0	-44.60	-30.20	-37.30	0.40

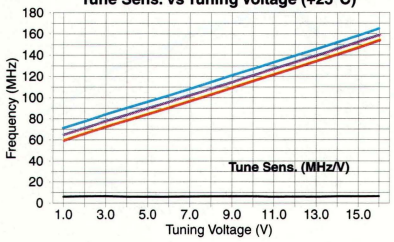


POS-150

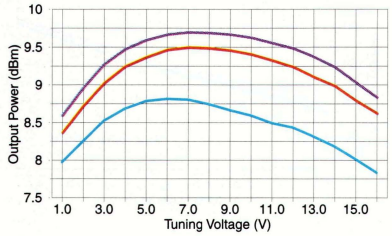
Linear Tuning - spec pg. 46

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	6.10	66.63	65.35	64.63	7.98	8.60	8.37
2.0	6.30	72.93	71.66	71.18	8.26	8.97	8.73
3.0	6.50	79.40	78.21	77.65	8.53	9.28	9.03
4.0	6.00	85.40	84.28	83.65	8.69	9.48	9.25
5.0	6.00	91.36	90.28	89.62	8.79	9.60	9.37
6.0	6.10	97.45	96.38	95.70	8.82	9.67	9.47
7.0	6.20	103.66	102.60	101.92	8.81	9.70	9.50
8.0	6.30	110.00	108.93	108.25	8.75	9.69	9.49
9.0	6.30	116.31	115.30	114.62	8.67	9.67	9.46
10.0	6.30	122.58	121.62	120.93	8.60	9.63	9.41
11.0	6.10	128.71	127.81	127.16	8.50	9.56	9.33
12.0	6.20	134.91	134.06	133.41	8.44	9.49	9.24
13.0	6.10	141.03	140.28	139.66	8.32	9.38	9.11
14.0	6.30	147.35	146.58	146.00	8.19	9.24	8.99
15.0	6.40	153.73	153.01	152.43	8.02	9.04	8.80
16.0	6.50	160.21	159.51	158.95	7.84	8.84	8.63

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

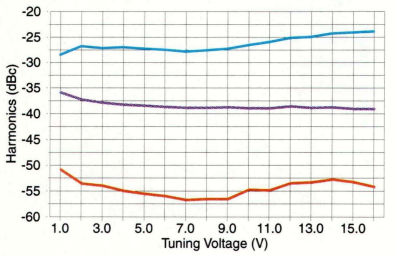


Power Output

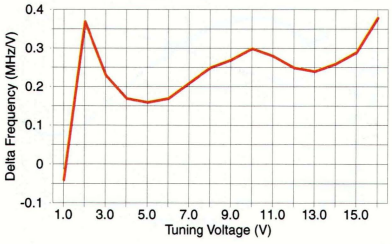


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-28.40	-35.80	-50.80	-0.04
2.0	-26.70	-37.20	-53.50	0.37
3.0	-27.10	-37.80	-53.90	0.23
4.0	-26.90	-38.20	-54.90	0.17
5.0	-27.20	-38.40	-55.50	0.16
6.0	-27.40	-38.60	-55.90	0.17
7.0	-27.80	-38.80	-56.70	0.21
8.0	-27.50	-38.80	-56.50	0.25
9.0	-27.20	-38.70	-56.50	0.27
10.0	-26.50	-38.90	-54.70	0.30
11.0	-25.90	-38.90	-54.80	0.28
12.0	-25.10	-38.50	-53.40	0.25
13.0	-24.90	-38.80	-53.30	0.24
14.0	-24.20	-38.70	-52.70	0.26
15.0	-24.00	-39.00	-53.20	0.29
16.0	-23.80	-39.00	-54.10	0.38

Harmonics



Frequency Pushing
(Supply Voltage 12V)

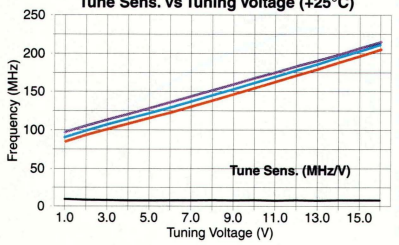


POS-200

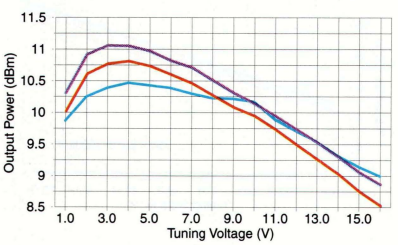
Linear Tuning - spec pg. 46

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	9.20	90.26	90.12	87.80	9.87	10.31	10.02
2.0	8.50	99.05	98.66	96.63	10.25	10.92	10.61
3.0	7.90	106.85	106.58	104.12	10.39	11.06	10.77
4.0	7.50	114.18	114.08	111.21	10.47	11.05	10.81
5.0	7.50	121.53	121.62	118.38	10.43	10.97	10.73
6.0	7.70	129.06	129.30	125.81	10.39	10.82	10.60
7.0	7.80	136.93	137.10	133.58	10.30	10.71	10.46
8.0	8.00	145.12	145.10	141.55	10.23	10.51	10.27
9.0	7.80	153.05	152.95	149.75	10.22	10.31	10.08
10.0	7.90	161.31	160.83	157.85	10.17	10.14	9.94
11.0	7.60	169.31	168.47	166.06	9.89	9.94	9.73
12.0	7.90	177.63	176.36	174.38	9.71	9.73	9.49
13.0	7.60	185.60	183.96	182.60	9.54	9.53	9.26
14.0	8.00	194.50	191.96	191.25	9.32	9.30	9.03
15.0	8.00	202.95	200.00	199.71	9.15	9.06	8.75
16.0	7.90	211.21	207.87	208.18	9.00	8.86	8.52

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

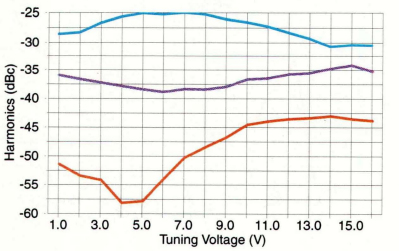


Power Output

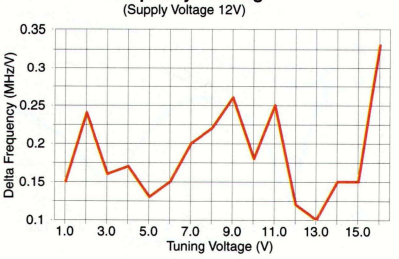


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-28.60	-36.00	-51.50	0.15
2.0	-28.30	-36.70	-53.50	0.24
3.0	-26.70	-37.30	-54.20	0.16
4.0	-25.70	-37.90	-58.20	0.17
5.0	-25.10	-38.50	-57.90	0.13
6.0	-25.30	-38.90	-54.10	0.15
7.0	-25.00	-38.40	-50.30	0.20
8.0	-25.30	-38.50	-48.50	0.22
9.0	-26.10	-38.00	-46.80	0.26
10.0	-26.60	-36.70	-44.60	0.18
11.0	-27.30	-36.50	-44.00	0.25
12.0	-28.30	-35.80	-43.60	0.12
13.0	-29.30	-35.60	-43.40	0.10
14.0	-30.70	-34.80	-43.10	0.15
15.0	-30.40	-34.20	-43.60	0.15
16.0	-30.50	-35.30	-43.90	0.33

Harmonics

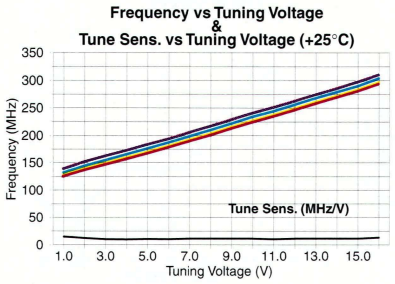


Frequency Pushing
(Supply Voltage 12V)

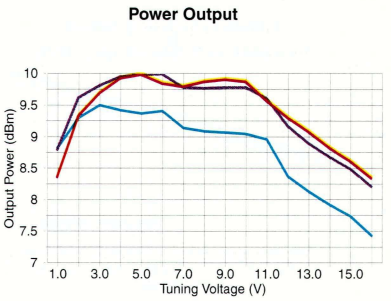


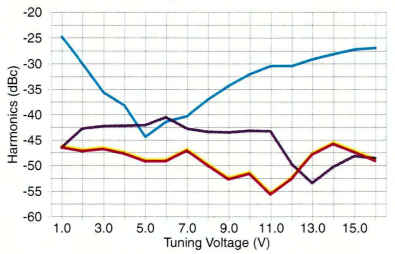
POS-300

Linear Tuning - spec pg. 46

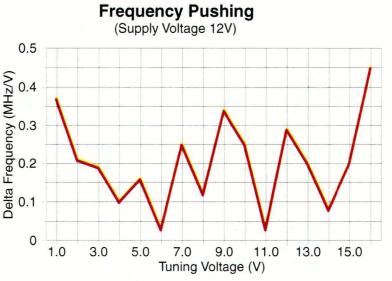


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	15.20	138.58	136.00	135.70	8.84	8.81	8.37
2.0	12.70	150.61	148.68	147.15	9.31	9.63	9.34
3.0	10.40	161.06	159.08	157.38	9.51	9.82	9.70
4.0	10.10	171.65	169.21	167.46	9.43	9.96	9.93
5.0	10.80	182.25	180.05	177.96	9.38	9.99	9.99
6.0	10.60	193.33	190.70	188.70	9.42	10.00	9.85
7.0	11.80	204.78	202.46	200.30	9.15	9.79	9.80
8.0	11.30	216.40	213.80	211.48	9.10	9.78	9.88
9.0	11.70	227.96	225.50	223.48	9.08	9.79	9.91
10.0	11.80	240.03	237.35	234.88	9.06	9.79	9.88
11.0	10.50	250.31	247.82	245.40	8.97	9.62	9.58
12.0	11.50	261.96	259.30	256.93	8.38	9.18	9.31
13.0	11.80	274.03	271.13	268.48	8.14	8.91	9.09
14.0	11.50	285.33	282.63	279.91	7.93	8.69	8.83
15.0	11.50	296.50	294.15	291.66	7.75	8.50	8.62
16.0	13.20	310.38	307.38	304.65	7.44	8.22	8.35



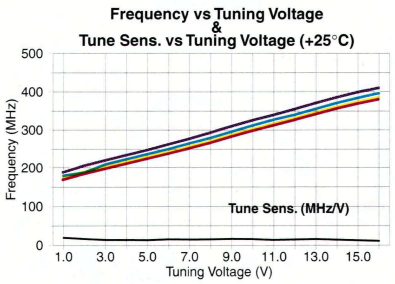


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-24.60	-46.30	-46.30	0.37
2.0	-29.70	-42.60	-47.00	0.21
3.0	-35.40	-42.10	-46.60	0.19
4.0	-38.00	-42.00	-47.50	0.10
5.0	-44.20	-41.90	-49.00	0.16
6.0	-41.20	-40.30	-49.00	0.03
7.0	-40.10	-42.60	-46.90	0.25
8.0	-36.80	-43.20	-49.80	0.12
9.0	-34.10	-43.30	-52.50	0.34
10.0	-31.80	-43.00	-51.40	0.25
11.0	-30.20	-43.10	-55.40	0.03
12.0	-30.20	-49.50	-52.40	0.29
13.0	-28.90	-53.20	-47.70	0.20
14.0	-27.90	-50.10	-45.60	0.08
15.0	-27.00	-48.00	-47.20	0.20
16.0	-26.70	-48.40	-48.90	0.45

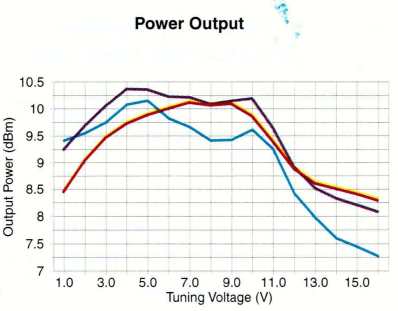


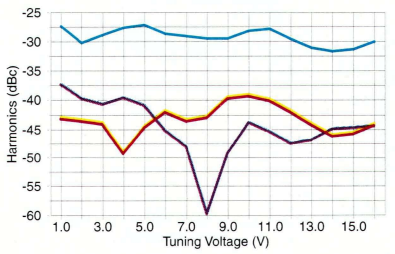
POS-400

Linear Tuning - spec pg. 46

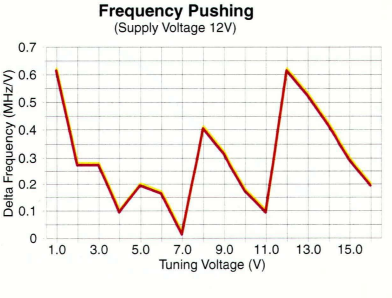


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	19.50	181.60	184.88	178.08	9.43	9.27	8.47
2.0	16.70	189.70	201.58	193.38	9.57	9.71	9.06
3.0	14.10	211.25	215.71	207.00	9.77	10.08	9.49
4.0	14.10	224.98	229.83	220.17	10.10	10.39	9.75
5.0	13.80	238.65	243.63	233.22	10.17	10.38	9.91
6.0	15.30	252.53	258.88	247.43	9.84	10.25	10.03
7.0	15.10	267.80	273.95	261.75	9.68	10.24	10.14
8.0	15.40	282.13	289.35	276.48	9.43	10.11	10.09
9.0	16.80	298.35	306.18	292.55	9.44	10.17	10.12
10.0	15.90	314.65	322.08	308.05	9.63	10.21	9.89
11.0	14.00	329.68	336.13	322.25	9.27	9.67	9.42
12.0	15.20	342.40	351.32	336.42	8.43	8.94	8.91
13.0	15.90	358.26	367.18	351.48	7.99	8.54	8.63
14.0	14.80	373.38	382.00	365.85	7.61	8.35	8.53
15.0	13.30	386.98	395.30	378.86	7.46	8.23	8.43
16.0	11.30	398.75	406.65	390.35	7.29	8.10	8.31





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-27.20	-37.10	-42.90	0.62
2.0	-30.10	-39.50	-43.30	0.28
3.0	-28.70	-40.50	-43.80	0.28
4.0	-27.50	-39.40	-49.10	0.10
5.0	-27.00	-40.70	-44.40	0.20
6.0	-28.50	-44.90	-41.80	0.17
7.0	-28.90	-47.80	-43.30	0.02
8.0	-29.30	-59.50	-42.70	0.41
9.0	-29.30	-49.00	-39.50	0.32
10.0	-28.00	-43.50	-39.10	0.18
11.0	-27.70	-45.10	-39.90	0.10
12.0	-29.40	-47.20	-41.80	0.62
13.0	-30.90	-46.60	-43.90	0.53
14.0	-31.50	-44.60	-45.90	0.42
15.0	-31.20	-44.40	-45.50	0.30
16.0	-29.90	-44.10	-44.00	0.20



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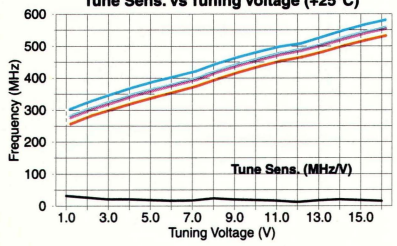
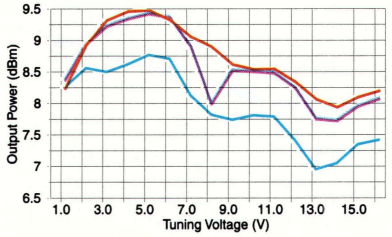
Linear Tuning - spec pg. 46

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	31.50	285.03	278.90	274.76	8.25	8.38	8.25
2.0	26.00	310.18	304.90	301.16	8.55	8.95	8.94
3.0	20.90	331.32	325.80	321.53	8.49	9.23	9.33
4.0	20.90	352.76	346.70	341.31	8.61	9.35	9.47
5.0	17.80	370.65	364.50	358.75	8.76	9.43	9.49
6.0	16.20	386.75	380.70	374.87	8.70	9.37	9.34
7.0	16.80	402.92	397.50	393.16	8.12	8.91	9.07
8.0	23.90	427.07	421.30	416.08	7.81	8.00	8.91
9.0	20.30	446.98	441.60	436.50	7.73	8.53	8.63
10.0	18.00	464.80	459.60	454.75	7.80	8.51	8.55
11.0	16.30	480.78	476.00	471.03	7.78	8.49	8.56
12.0	11.90	490.28	487.90	483.67	7.40	8.25	8.35
13.0	16.80	511.07	504.80	500.43	6.94	7.76	8.08
14.0	19.60	531.23	524.40	519.33	7.04	7.73	7.95
15.0	17.30	548.65	541.70	536.06	7.34	7.96	8.11
16.0	14.60	563.30	556.30	550.38	7.41	8.08	8.21

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

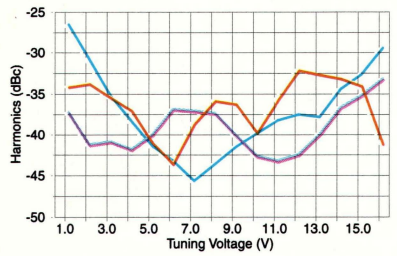


Power Output

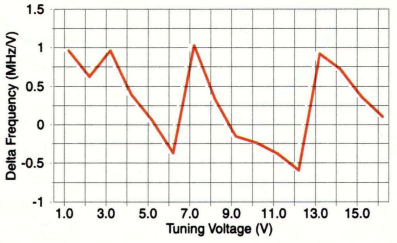


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-26.60	-37.30	-34.10	0.97
2.0	-30.90	-41.30	-33.70	0.64
3.0	-35.30	-40.90	-35.40	0.97
4.0	-38.40	-41.90	-37.00	0.41
5.0	-41.50	-40.00	-41.00	0.07
6.0	-43.30	-36.90	-43.60	-0.36
7.0	-45.70	-37.10	-38.60	1.04
8.0	-43.70	-37.40	-35.80	0.35
9.0	-41.60	-40.10	-36.20	-0.14
10.0	-39.90	-42.70	-39.70	-0.23
11.0	-38.30	-43.30	-35.70	-0.37
12.0	-37.60	-42.50	-32.10	-0.58
13.0	-37.90	-40.00	-32.60	0.93
14.0	-34.50	-36.70	-33.10	0.73
15.0	-32.70	-35.20	-34.00	0.38
16.0	-29.50	-33.20	-41.10	0.12

Harmonics



Frequency Pushing (Supply Voltage 12V)



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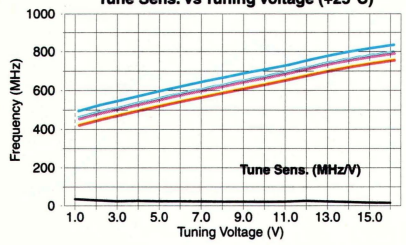
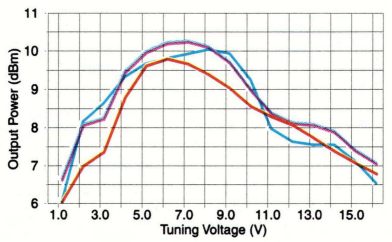
Linear Tuning - spec pg. 46

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	35.00	465.25	458.58	452.66	6.03	6.65	6.07
2.0	29.60	495.97	488.18	481.77	8.15	8.08	7.02
3.0	24.30	520.33	512.46	506.55	8.63	8.25	7.39
4.0	25.30	545.93	537.73	531.95	9.31	9.46	8.82
5.0	24.30	570.77	562.06	556.06	9.66	9.98	9.64
6.0	23.80	594.83	585.85	579.35	9.80	10.21	9.82
7.0	22.70	617.68	608.52	601.52	9.91	10.25	9.69
8.0	21.90	640.03	630.40	623.18	10.03	10.11	9.41
9.0	21.70	661.98	652.12	644.62	9.92	9.71	9.06
10.0	20.80	681.98	672.95	665.68	9.24	9.00	8.59
11.0	21.90	702.20	694.83	688.36	7.96	8.39	8.31
12.0	25.50	728.47	720.38	712.66	7.62	8.13	8.09
13.0	23.00	752.52	743.41	734.83	7.54	8.09	7.76
14.0	19.80	772.63	763.22	754.73	7.54	7.90	7.41
15.0	17.20	789.40	780.43	772.20	7.12	7.42	7.10
16.0	15.50	804.72	795.96	787.93	6.53	7.07	6.81

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

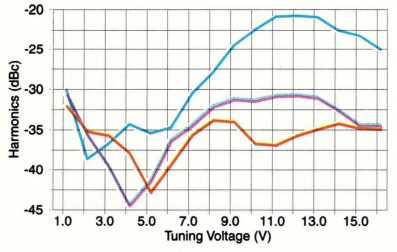


Power Output

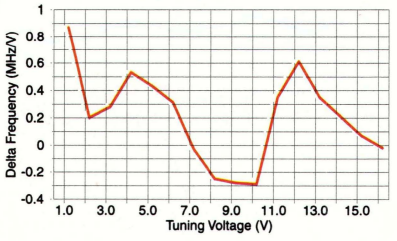


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-30.20	-30.50	-32.00	0.88
2.0	-38.70	-35.60	-35.10	0.21
3.0	-36.80	-39.50	-35.60	0.29
4.0	-34.40	-44.40	-37.80	0.54
5.0	-35.50	-41.40	-42.70	0.44
6.0	-34.80	-36.30	-39.20	0.32
7.0	-30.60	-34.40	-35.50	-0.02
8.0	-28.00	-32.10	-33.70	-0.24
9.0	-24.60	-31.20	-33.90	-0.27
10.0	-22.50	-31.40	-36.60	-0.28
11.0	-20.90	-30.80	-36.80	0.36
12.0	-20.80	-30.70	-35.60	0.62
13.0	-21.00	-31.00	-34.80	0.36
14.0	-22.60	-32.60	-34.10	0.22
15.0	-23.30	-34.40	-34.70	0.08
16.0	-25.10	-34.40	-34.80	-0.01

Harmonics



Frequency Pushing (Supply Voltage 12V)



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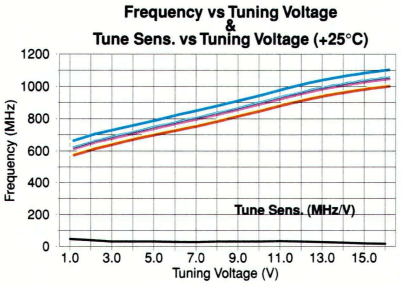
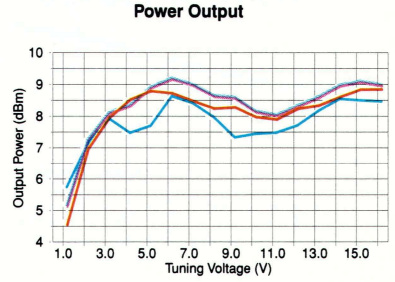
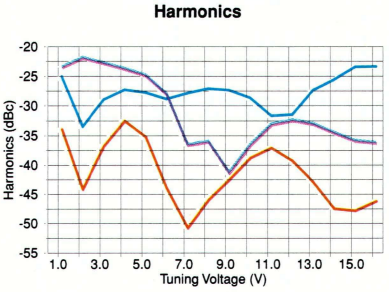
Linear Tuning - spec pg. 46

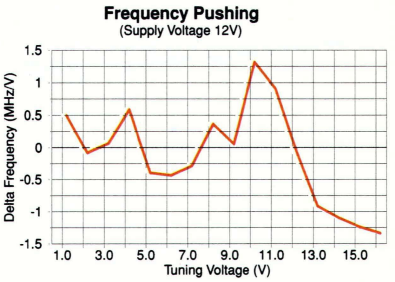


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	48.00	626.90	616.50	609.08	5.72	5.15	4.56
2.0	39.90	667.15	656.40	649.63	7.12	7.25	6.98
3.0	30.60	697.26	686.95	681.65	7.91	8.11	7.97
4.0	30.30	725.92	717.23	711.85	7.45	8.34	8.55
5.0	31.20	755.70	748.42	739.97	7.68	8.91	8.81
6.0	29.00	788.73	777.42	766.42	8.61	9.19	8.74
7.0	27.70	816.86	805.13	793.90	8.39	8.99	8.50
8.0	30.30	846.70	835.47	824.70	7.95	8.64	8.27
9.0	31.90	878.96	867.33	856.78	7.31	8.58	8.30
10.0	31.00	910.30	898.35	888.22	7.42	8.15	8.00
11.0	34.40	946.17	932.78	922.00	7.46	8.03	7.92
12.0	31.90	979.23	964.68	952.73	7.69	8.32	8.26
13.0	27.50	1007.05	992.13	978.85	8.15	8.60	8.36
14.0	23.00	1029.60	1015.10	1001.43	8.52	8.97	8.63
15.0	18.90	1048.83	1034.03	1020.18	8.48	9.09	8.86
16.0	16.90	1065.93	1050.93	1036.63	8.44	8.98	8.87





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-25.20	-23.50	-33.80	0.51
2.0	-33.60	-21.90	-44.10	-0.07
3.0	-29.10	-22.80	-36.70	0.08
4.0	-27.40	-23.80	-32.40	0.60
5.0	-27.90	-24.90	-35.10	-0.38
6.0	-29.00	-28.00	-43.80	-0.42
7.0	-28.00	-36.60	-50.70	-0.27
8.0	-27.20	-36.00	-45.90	0.38
9.0	-27.50	-41.30	-42.40	0.07
10.0	-28.80	-36.60	-38.70	1.33
11.0	-31.80	-33.10	-37.00	0.92
12.0	-31.60	-32.40	-39.20	-0.05
13.0	-27.50	-33.00	-42.80	-0.90
14.0	-25.70	-34.50	-47.40	-1.08
15.0	-23.60	-35.90	-47.70	-1.22
16.0	-23.50	-36.20	-46.10	-1.32



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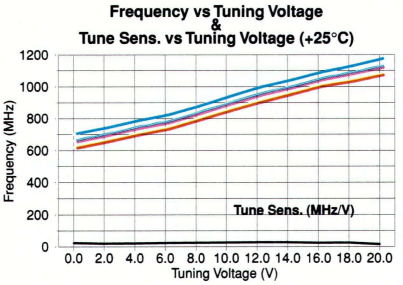
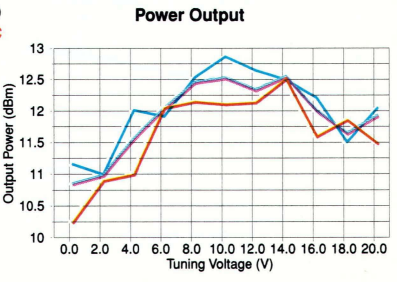
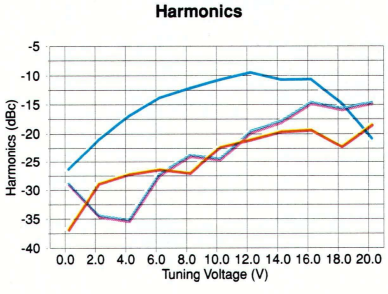
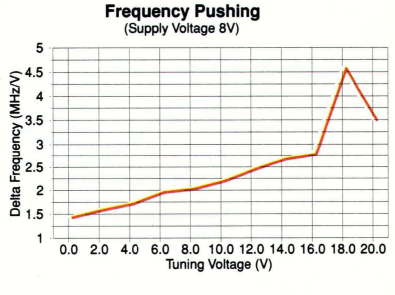


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	23.35	667.98	660.15	652.46	11.14	10.85	10.25
2.0	19.99	705.71	697.66	690.63	10.98	10.98	10.90
4.0	20.73	749.19	741.35	732.14	12.00	11.56	11.00
6.0	24.32	786.40	777.56	770.01	11.90	12.04	12.05
8.0	25.69	841.58	833.68	826.97	12.52	12.45	12.15
10.0	26.61	901.15	893.70	884.16	12.85	12.52	12.11
12.0	27.64	959.47	949.31	938.49	12.63	12.33	12.14
14.0	27.49	1002.41	994.54	986.85	12.48	12.54	12.51
16.0	23.00	1052.01	1046.38	1037.38	12.20	12.00	11.60
18.0	25.88	1092.75	1083.05	1067.83	11.49	11.64	11.86
20.0	14.94	1138.66	1124.15	1108.01	12.03	11.92	11.49





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.0	-26.45	-28.96	-36.75	1.45
2.0	-21.14	-34.52	-28.82	1.60
4.0	-17.10	-35.34	-27.13	1.73
6.0	-13.96	-27.35	-26.30	1.97
8.0	-12.30	-23.93	-26.93	2.04
10.0	-10.84	-24.58	-22.23	2.21
12.0	-9.60	-19.71	-20.91	2.46
14.0	-10.84	-17.99	-19.54	2.69
16.0	-10.78	-14.74	-19.27	2.79
18.0	-14.89	-15.81	-22.11	4.59
20.0	-20.96	-14.73	-18.43	3.52



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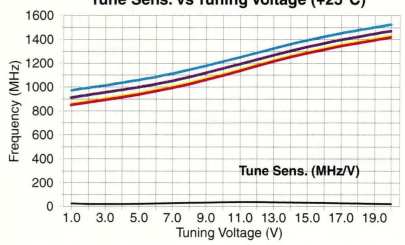
POS-1400A

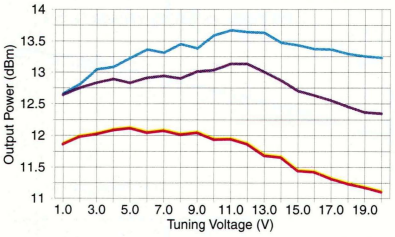
Linear Tuning - spec pg. 46

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

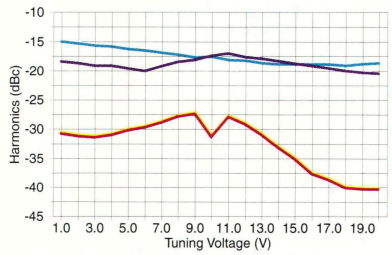


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	25.17	913.50	896.12	875.39	12.67	12.65	11.87
2.0	21.10	934.51	917.21	897.43	12.82	12.76	11.99
3.0	20.48	955.50	937.69	918.48	13.05	12.84	12.03
4.0	21.46	976.98	959.15	940.40	13.09	12.90	12.09
5.0	23.09	1000.48	982.24	964.03	13.23	12.84	12.12
6.0	25.51	1025.74	1007.75	989.88	13.37	12.92	12.05
7.0	28.23	1053.56	1035.98	1018.53	13.32	12.95	12.08
8.0	31.18	1084.54	1067.16	1050.13	13.46	12.91	12.02
9.0	34.57	1118.95	1101.73	1084.97	13.39	13.02	12.05
10.0	37.18	1156.59	1138.91	1122.47	13.60	13.04	11.94
11.0	37.83	1194.46	1176.74	1161.44	13.68	13.14	11.95
12.0	38.10	1231.23	1214.84	1201.40	13.65	13.14	11.87
13.0	36.98	1267.48	1251.82	1240.25	13.64	13.01	11.69
14.0	35.82	1302.37	1287.64	1276.83	13.48	12.88	11.66
15.0	33.57	1335.12	1321.20	1310.80	13.44	12.71	11.45
16.0	30.63	1365.12	1351.84	1341.78	13.38	12.64	11.43
17.0	28.42	1393.09	1380.26	1370.33	13.37	12.56	11.32
18.0	26.47	1419.09	1406.73	1396.93	13.30	12.46	11.24
19.0	24.37	1443.09	1431.10	1421.00	13.26	12.37	11.18
20.0	22.61	1465.48	1453.71	1444.30	13.24	12.35	11.11

Power Output



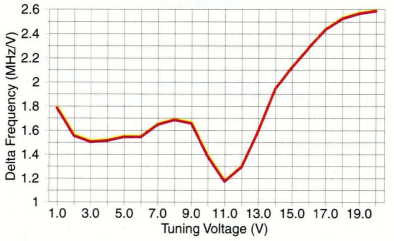
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-14.87	-18.25	-30.58	1.79
2.00	-15.19	-18.54	-31.01	1.56
3.00	-15.55	-18.98	-31.23	1.51
4.00	-15.73	-18.96	-30.82	1.52
5.00	-16.15	-19.45	-30.03	1.55
6.00	-16.39	-19.88	-29.54	1.55
7.00	-16.75	-19.02	-28.71	1.65
8.00	-17.09	-18.30	-27.70	1.69
9.00	-17.55	-17.96	-27.23	1.66
10.00	-17.45	-17.26	-31.17	1.39
11.00	-17.98	-16.85	-27.76	1.18
12.00	-18.08	-17.51	-29.03	1.30
13.00	-18.52	-17.77	-30.84	1.60
14.00	-18.68	-18.15	-32.96	1.95
15.00	-18.69	-18.61	-34.95	2.13
16.00	-18.75	-19.01	-37.46	2.29
17.00	-18.73	-19.38	-38.52	2.44
18.00	-18.94	-19.83	-39.87	2.53
19.00	-18.67	-20.14	-40.15	2.57
20.00	-18.53	-20.30	-40.17	2.59

Frequency Pushing

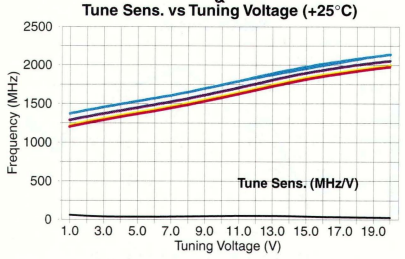
(Supply Voltage 8V)



POS-2000A

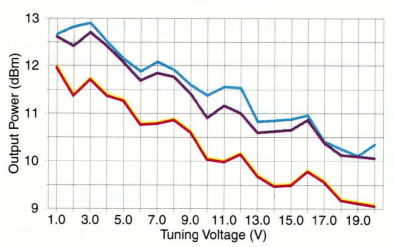
Linear Tuning - spec pg. 46

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

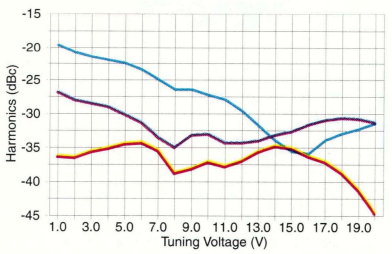


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	60.22	1315.76	1298.69	1282.39	12.68	12.63	11.97
2.0	45.61	1360.30	1344.30	1329.07	12.83	12.43	11.39
3.0	40.69	1400.13	1384.99	1370.50	12.91	12.72	11.73
4.0	38.28	1438.08	1423.27	1409.23	12.52	12.43	11.39
5.0	37.88	1475.67	1461.15	1447.41	12.15	12.08	11.28
6.0	38.21	1513.49	1499.36	1485.93	11.89	11.71	10.78
7.0	38.97	1552.21	1538.33	1525.27	12.09	11.86	10.80
8.0	40.98	1593.01	1579.31	1566.39	11.92	11.78	10.88
9.0	44.58	1639.49	1623.89	1610.31	11.61	11.43	10.62
10.0	46.93	1686.88	1670.81	1656.97	11.39	10.92	10.05
11.0	48.90	1735.04	1719.71	1705.77	11.57	11.18	10.00
12.0	49.42	1784.37	1769.13	1755.29	11.55	11.02	10.16
13.0	48.15	1831.94	1817.28	1803.71	10.84	10.61	9.70
14.0	45.61	1877.13	1862.89	1849.52	10.86	10.64	9.49
15.0	42.30	1919.10	1905.19	1891.96	10.89	10.67	9.51
16.0	38.45	1957.47	1943.64	1930.56	10.97	10.88	9.80
17.0	35.00	1992.45	1978.64	1965.61	10.42	10.40	9.58
18.0	31.99	2024.60	2010.62	1997.48	10.26	10.14	9.19
19.0	29.29	2054.18	2039.91	2026.75	10.12	10.11	9.13
20.0	27.14	2081.17	2067.06	2053.70	10.36	10.07	9.07

Power Output



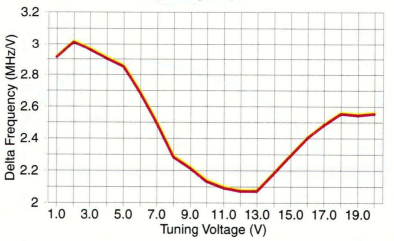
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-19.50	-26.67	-36.17	2.92
2.00	-20.66	-27.83	-36.33	3.02
3.00	-21.33	-28.33	-35.50	2.97
4.00	-21.84	-28.84	-35.00	2.91
5.00	-22.34	-30.00	-34.34	2.86
6.00	-23.34	-31.17	-34.17	2.69
7.00	-24.84	-33.34	-35.34	2.50
8.00	-26.33	-34.83	-38.66	2.29
9.00	-26.33	-33.00	-38.00	2.22
10.00	-27.16	-32.83	-37.00	2.14
11.00	-27.83	-34.16	-37.66	2.10
12.00	-29.50	-34.16	-36.83	2.08
13.00	-31.67	-33.83	-35.50	2.08
14.00	-33.83	-33.00	-34.66	2.19
15.00	-35.50	-32.50	-35.00	2.30
16.00	-35.84	-31.50	-36.17	2.41
17.00	-33.83	-30.83	-37.00	2.49
18.00	-32.83	-30.50	-38.66	2.56
19.00	-32.16	-30.66	-41.16	2.55
20.00	-31.33	-31.16	-44.50	2.56

Frequency Pushing

(Supply Voltage 8V)

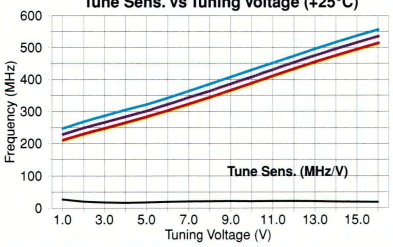


POS-500W

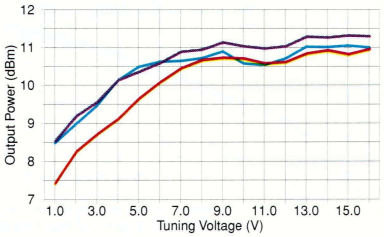
Linear Tuning - spec pg. 47

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	27.16	231.00	228.57	227.38	8.47	8.53	7.43
2.0	20.57	252.12	249.14	247.00	8.97	9.18	8.26
3.0	17.91	270.62	267.05	264.42	9.46	9.56	8.71
4.0	17.09	288.34	284.14	281.98	10.13	10.13	9.12
5.0	18.18	305.68	302.31	300.44	10.48	10.35	9.65
6.0	20.10	325.68	322.41	319.82	10.62	10.59	10.08
7.0	21.10	347.55	343.50	340.20	10.64	10.88	10.45
8.0	21.75	369.92	365.25	361.49	10.71	10.94	10.67
9.0	22.09	392.29	387.34	383.57	10.89	11.13	10.73
10.0	21.91	414.01	409.25	406.00	10.57	11.03	10.71
11.0	22.20	435.15	431.45	428.52	10.53	10.97	10.58
12.0	22.41	457.29	453.86	450.64	10.70	11.03	10.62
13.0	21.81	479.42	475.67	471.98	11.01	11.28	10.84
14.0	20.92	500.67	496.59	492.48	11.00	11.26	10.92
15.0	19.96	520.94	516.55	512.04	11.04	11.31	10.82
16.0	19.04	540.24	535.59	530.74	10.99	11.29	10.95

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

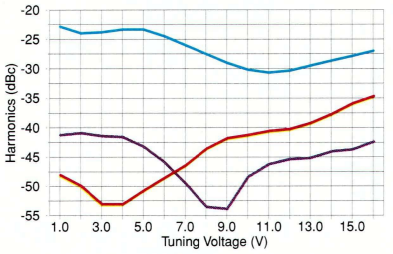


Power Output

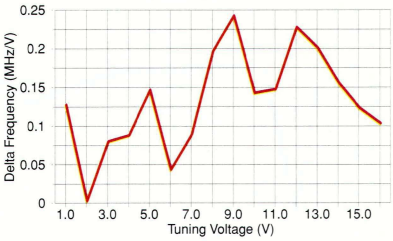


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-22.83	-41.17	-48.00	0.13
2.0	-24.00	-40.84	-49.84	0.00
3.0	-23.83	-41.33	-53.00	0.08
4.0	-23.34	-41.50	-53.00	0.09
5.0	-23.34	-43.17	-50.67	0.15
6.0	-24.50	-45.84	-48.50	0.04
7.0	-26.00	-49.50	-46.33	0.09
8.0	-27.50	-53.50	-43.50	0.20
9.0	-29.00	-53.84	-41.67	0.24
10.0	-30.16	-48.33	-41.16	0.14
11.0	-30.67	-46.17	-40.50	0.15
12.0	-30.33	-45.33	-40.16	0.23
13.0	-29.50	-45.17	-39.17	0.20
14.0	-28.66	-44.00	-37.66	0.16
15.0	-27.84	-43.67	-35.84	0.12
16.0	-27.00	-42.33	-34.66	0.10

Harmonics



Frequency Pushing
(Supply Voltage 12V)

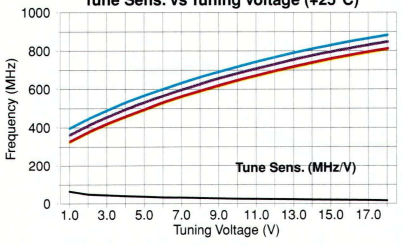


POS-800W

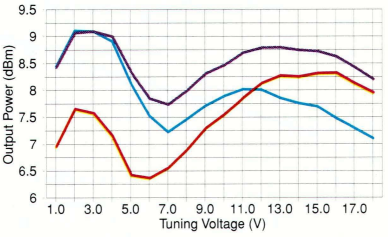
Linear Tuning - spec pg. 47

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	63.79	371.48	363.89	357.49	8.44	8.43	6.97
2.0	48.79	420.02	412.69	405.46	9.11	9.07	7.66
3.0	44.06	464.34	456.75	448.26	9.10	9.10	7.58
4.0	40.96	505.55	497.70	487.56	8.91	9.00	7.16
5.0	37.01	542.79	534.71	524.35	8.14	8.35	6.43
6.0	33.58	576.21	568.29	560.14	7.53	7.85	6.37
7.0	32.11	608.00	600.40	592.67	7.23	7.74	6.56
8.0	30.00	638.18	630.39	622.48	7.46	7.99	6.90
9.0	27.97	666.38	658.36	650.29	7.71	8.31	7.30
10.0	26.46	692.97	684.82	676.62	7.89	8.47	7.56
11.0	25.11	718.14	709.92	701.57	8.02	8.70	7.86
12.0	23.87	741.94	733.79	725.24	8.01	8.79	8.14
13.0	22.63	764.43	756.42	747.62	7.86	8.80	8.28
14.0	21.29	785.53	777.71	768.76	7.76	8.75	8.26
15.0	19.88	805.28	797.59	788.59	7.70	8.73	8.32
16.0	18.53	823.70	816.12	807.11	7.48	8.63	8.33
17.0	17.30	840.93	833.41	824.36	7.30	8.43	8.14
18.0	16.29	857.16	849.70	840.45	7.11	8.21	7.96

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

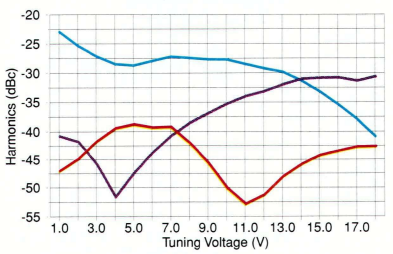


Power Output

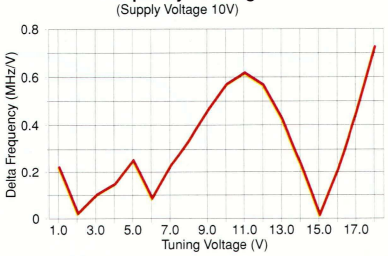


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-22.89	-40.71	-46.94	0.22
2.0	-25.32	-41.70	-44.79	0.02
3.0	-27.10	-45.75	-41.60	0.10
4.0	-28.41	-51.55	-39.30	0.15
5.0	-28.67	-47.37	-38.66	0.25
6.0	-27.89	-43.72	-39.19	0.09
7.0	-27.14	-40.66	-39.12	0.23
8.0	-27.39	-38.44	-41.90	0.34
9.0	-27.60	-36.84	-45.51	0.46
10.0	-27.68	-35.21	-49.95	0.57
11.0	-28.43	-33.95	-52.78	0.62
12.0	-29.19	-33.12	-51.22	0.57
13.0	-29.76	-31.93	-48.02	0.43
14.0	-31.25	-30.97	-45.76	0.24
15.0	-33.14	-30.79	-44.19	0.02
16.0	-35.37	-30.75	-43.40	0.21
17.0	-37.90	-31.29	-42.64	0.46
18.0	-40.81	-30.57	-42.55	0.73

Harmonics



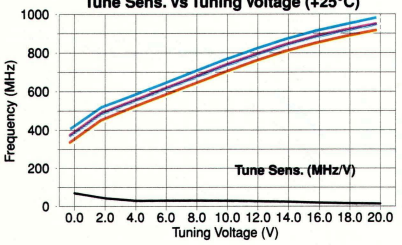
Frequency Pushing
(Supply Voltage 10V)



POS-900W

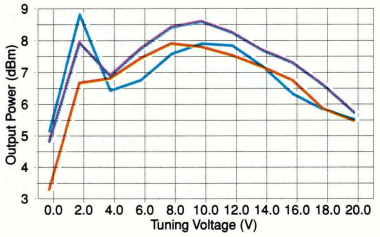
Linear Tuning - spec pg. 47

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

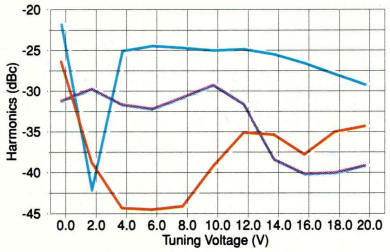


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	70.29	383.72	372.25	360.35	5.18	4.84	3.29
2.0	43.09	494.94	485.63	475.93	8.84	7.94	6.67
4.0	29.77	555.22	547.86	541.43	6.46	6.91	6.81
6.0	30.79	615.16	609.39	602.55	6.79	7.76	7.44
8.0	30.60	677.59	670.62	662.14	7.60	8.43	7.91
10.0	29.94	738.59	731.23	722.04	7.93	8.61	7.80
12.0	27.86	794.88	788.12	779.69	7.87	8.26	7.53
14.0	25.17	845.79	839.79	832.28	7.21	7.70	7.17
16.0	20.36	889.66	883.31	874.86	6.35	7.31	6.75
18.0	16.44	925.14	917.62	909.65	5.85	6.61	5.85
20.0	14.94	958.19	948.15	940.37	5.55	5.75	5.48

Power Output



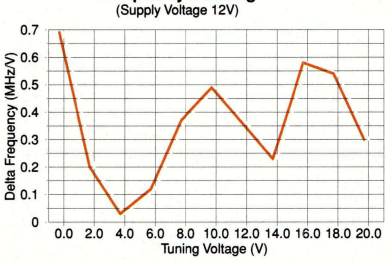
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-21.72	-31.22	-26.39
2.0	-42.06	-29.73	-38.73
4.0	-25.01	-31.68	-44.34
6.0	-24.37	-32.20	-44.53
8.0	-24.61	-30.78	-44.11
10.0	-24.93	-29.26	-39.26
12.0	-24.78	-31.62	-35.12
14.0	-25.39	-38.39	-35.39
16.0	-26.49	-40.16	-37.82
18.0	-27.85	-40.01	-35.01
20.0	-29.15	-39.15	-34.32

FREQ. PUSHING (MHz/V)
0.69
0.20
0.03
0.12
0.37
0.49
0.36
0.23
0.58
0.54
0.30

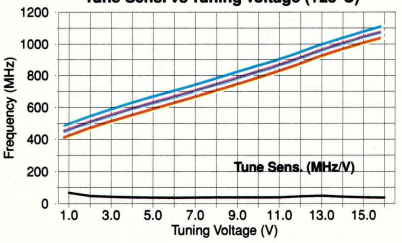
Frequency Pushing (Supply Voltage 12V)



POS-1000W

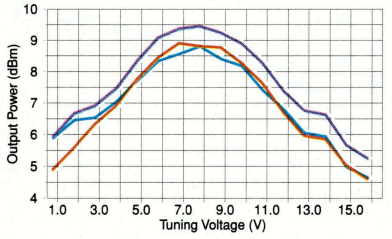
Linear Tuning - spec pg. 47

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

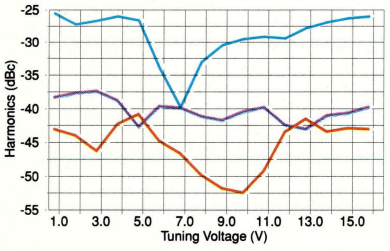


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	68.09	459.29	450.47	443.70	5.92	5.94	4.89
2.0	48.97	508.38	499.44	492.29	6.48	6.67	5.58
3.0	43.41	551.74	542.85	534.72	6.56	6.92	6.32
4.0	40.67	593.09	583.52	574.39	7.06	7.47	6.91
5.0	38.57	632.14	622.09	612.62	7.73	8.34	7.76
6.0	36.83	669.03	658.92	649.90	8.36	9.09	8.44
7.0	37.89	706.90	696.80	687.98	8.59	9.38	8.91
8.0	39.57	746.75	736.37	727.51	8.83	9.47	8.81
9.0	40.34	787.31	776.71	767.87	8.43	9.25	8.77
10.0	40.13	827.22	816.84	808.33	8.20	8.90	8.27
11.0	40.19	865.84	857.03	849.39	7.43	8.27	7.63
12.0	46.09	911.52	903.12	895.20	6.81	7.38	6.69
13.0	49.66	961.39	952.78	944.98	6.08	6.77	5.96
14.0	43.13	1002.59	995.90	988.97	5.96	6.64	5.86
15.0	40.58	1042.71	1036.48	1029.46	5.00	5.68	5.03
16.0	37.19	1080.96	1073.67	1066.10	4.67	5.25	4.60

Power Output



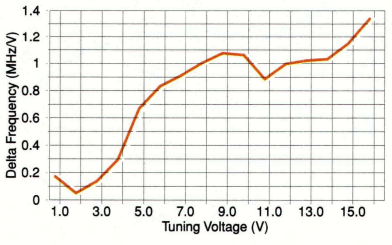
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-25.42	-38.30	-43.11
2.0	-27.14	-37.65	-44.04
3.0	-26.57	-37.38	-46.32
4.0	-25.87	-38.77	-42.35
5.0	-26.49	-42.71	-40.87
6.0	-33.79	-39.65	-44.79
7.0	-39.71	-39.86	-46.69
8.0	-32.97	-41.14	-49.83
9.0	-30.38	-41.74	-51.82
10.0	-29.44	-40.43	-52.47
11.0	-29.06	-39.80	-49.26
12.0	-29.35	-42.42	-43.52
13.0	-27.72	-43.02	-41.58
14.0	-26.78	-41.02	-43.47
15.0	-26.13	-40.64	-42.95
16.0	-25.89	-39.76	-43.10

FREQ. PUSHING (MHz/V)
0.17
0.05
0.14
0.29
0.67
0.83
0.91
1.00
1.08
1.06
0.88
1.00
1.02
1.03
1.15
1.34

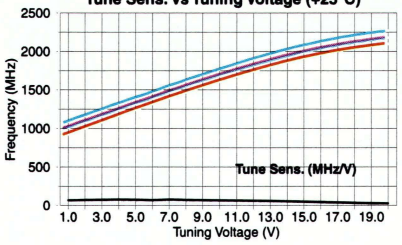
Frequency Pushing (Supply Voltage 12V)



POS-2120W

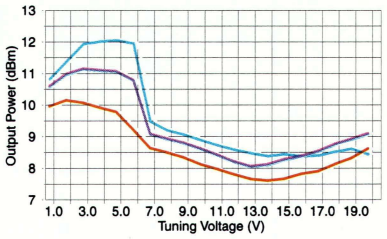
Linear Tuning - spec pg. 47

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

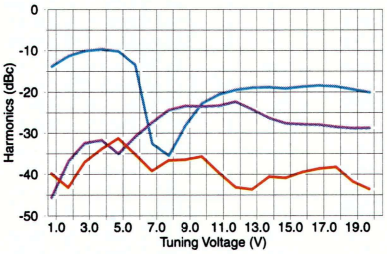


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	70.10	1024.07	1006.92	990.45	10.84	10.59	9.95
2.0	75.32	1098.83	1082.24	1067.13	11.40	10.98	10.14
3.0	77.40	1176.13	1159.63	1146.80	11.95	11.15	10.06
4.0	78.76	1253.19	1238.39	1227.80	12.03	11.11	9.91
5.0	77.99	1329.27	1316.38	1308.07	12.07	11.07	9.77
6.0	73.08	1400.26	1389.46	1385.25	11.97	10.79	9.21
7.0	79.36	1480.48	1468.83	1461.52	9.50	9.08	8.63
8.0	74.19	1556.33	1543.02	1534.97	9.22	8.93	8.49
9.0	72.06	1629.11	1615.09	1606.70	9.08	8.80	8.34
10.0	70.78	1700.49	1685.86	1677.24	8.91	8.62	8.12
11.0	68.35	1769.82	1754.22	1745.31	8.74	8.42	7.96
12.0	65.44	1836.10	1819.65	1810.74	8.60	8.21	7.80
13.0	61.98	1899.35	1881.64	1872.91	8.49	8.06	7.65
14.0	56.48	1958.14	1938.11	1929.74	8.40	8.12	7.60
15.0	52.27	2012.15	1990.39	1982.21	8.46	8.28	7.66
16.0	47.11	2061.72	2037.50	2028.82	8.39	8.38	7.81
17.0	42.62	2105.52	2080.12	2070.90	8.42	8.54	7.89
18.0	37.02	2143.19	2117.14	2106.57	8.54	8.76	8.12
19.0	32.29	2177.76	2149.43	2137.26	8.63	8.92	8.31
20.0	28.29	2203.05	2177.72	2165.17	8.45	9.09	8.61

Power Output

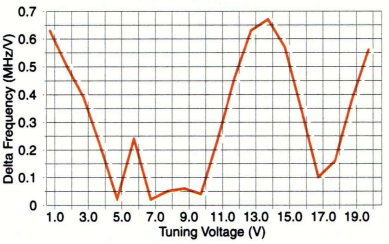


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-13.79	-45.60	-39.81	0.63
2.0	-11.19	-36.91	-43.23	0.50
3.0	-9.96	-32.43	-37.10	0.39
4.0	-9.57	-31.70	-33.92	0.21
5.0	-10.10	-35.01	-31.29	0.02
6.0	-13.44	-30.89	-35.16	0.24
7.0	-32.47	-27.41	-39.19	0.02
8.0	-35.41	-24.39	-36.70	0.05
9.0	-28.02	-23.37	-36.47	0.06
10.0	-22.69	-23.51	-35.73	0.04
11.0	-20.51	-23.34	-39.57	0.24
12.0	-19.40	-22.36	-43.18	0.46
13.0	-18.85	-24.20	-43.73	0.63
14.0	-18.77	-26.31	-40.62	0.67
15.0	-19.05	-27.64	-40.84	0.57
16.0	-18.60	-27.83	-39.48	0.34
17.0	-18.36	-27.95	-38.62	0.10
18.0	-18.55	-28.45	-38.27	0.16
19.0	-19.31	-28.80	-41.78	0.38
20.0	-20.01	-28.75	-43.63	0.56

Frequency Pushing
(Supply Voltage 12V)



VOLTAGE CONTROLLED OSCILLATORS

LINEAR TUNING *SURFACE MOUNT*

WIDE BAND *12.5 to 3000MHz*

JTOS

ROS

MODEL◆ NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
JTOS-25	12.5-25		+8.0	1	11	-95	-115	-135	-155	0.03	0.02	1.0-4.0	-26	-13	130	12	20	59	BK377	jc	18.95
JTOS-50	25-47		+8.5	1	15	-88	-108	-127	-147	0.06	0.04	2.0-2.6	-19	-12	50	12	20	60	BK377	jc	13.95
JTOS-75	37.5-75		+8.0	1	16	-89	-110	-130	-140	0.15	0.11	2.8-4.0	-27	-20	125	12	20	60	BK377	jc	13.95
JTOS-100	50-100		+8.3	1	16	-83	-108	-128	-140	0.6	0.2	3.7-4.8	-35	-20	100	12	18	61	BK377	jc	13.95
JTOS-150	75-150		+9.5	1	16	-82	-106	-127	-147	0.8	0.3	5.8-6.7	-23	-17	112	12	20	61	BK377	jc	13.95
JTOS-200	100-200		+10.0	1	16	-84	-105	-124	-145	1.0	0.2	6-10	-25	-20	110	12	20	62	BK377	jc	13.95
JTOS-300	150-280		+9.0	1	16	-82	-102	-122	-142	1.0	0.2	9-14	-28	-20	120	12	20	62	BK377	jc	15.95
JTOS-400	200-380		+9.0	1	16	-82	-102	-122	-142	1.4	0.4	10.5-17.1	-25	-20	130	12	20	63	BK377	jc	15.95
JTOS-535	300-525		+9.5	1	16	-75	-97	-117	-137	2.0	0.5	10-24	-28	-20	115	12	20	63	BK377	jc	15.95
JTOS-765	485-765		+8.0	1	16	-75	-98	-118	-138	2.0	0.5	20-30	-30	-20	100	12	20	64	BK377	jc	16.95
JTOS-1025	685-1025		+8.6	1	16	-70	-94	-114	-134	5.0	0.6	21-36	-28	-20	100	12	22	64	BK377	jc	18.95
JTOS-1300	900-1300		+7.0	1	20	-70	-95	-115	-135	12	1.0	25-45	-28	-17	1000	12	30	65	BK377	jc	18.95
JTOS-1550	1150-1550		+7.0	0.5	20	-73	-101	-121	-141	14	0.7	22-32	-20	-10	2700	12	30	65	BK377	jc	19.95
JTOS-1650	1200-1650		+7.0	1	13	-70	-95	-115	-135	15	1.5	50-90	-20	-14	1000	12	30	66	BK377	jc	19.95
JTOS-1750	1350-1750		+7.0	0.5	20	-73	-101	-121	-141	7	0.5	26-35	-16	-10	2700	12	30	66	BK377	jc	19.95
JTOS-1910	1625-1910		+7.0	1	12	-69	-97	-117	-137	10	1.0	30-60	-20	-15	2500	12	20	67	BK377	jc	19.95
JTOS-1950	1550-1950		+7.0	0.5	20	-75	-103	-125	-144	7	0.6	23-32	-14	-10	8000	12	30	67	BK377	jc	19.95
JTOS-2000	1370-2000		+12.0	1	22	-70	-95	-115	-135	40	1.5	30-50	-11	-8	1000	8	30	68	BK377	jc	19.95
JTOS-2700V	2050-2700		+8.0	0.5	18	-72	-94	-114	-134	5	1.0	46-56	-25	-10	8000	5	20	68	BK377	jc	21.95
JTOS-3000	2300-3000		+10.0	0.5	12	-60	-90	-110	-130	50	5.0	50-150	-22	-12	20000	5	25	69	BK377	jc	20.95
ROS-100	50-100		+8.3	0.5	17	-75	-105	-125	-145	0.6	0.3	3.0-5.0	-30	-20	100	12	20	69	CK605	kg	12.95
ROS-150	75-150		+9.5	1	18	-80	-103	-127	-144	0.8	0.3	4.0-6.8	-23	-16	100	12	20	70	CK605	kg	12.95
ROS-200	100-200		+10.0	1	17	-80	-105	-125	-145	0.6	0.3	6-11	-30	-20	100	12	20	70	CK605	kg	12.95
ROS-300	150-280		+9.0	1	16	-80	-102	-122	-142	0.5	0.3	7-17	-28	-18	100	12	20	71	CK605	kg	14.95
ROS-400	200-380		+9.5	0.5	17	-80	-100	-120	-140	0.2	0.3	9-22	-24	-18	100	12	20	71	CK605	kg	14.95
ROS-535	300-525		+6.0	1	17	-75	-98	-118	-138	0.5	0.4	9-27	-20	-15	100	12	20	72	CK605	kg	14.95
ROS-765	485-765		+6.0	1	16	-74	-95	-115	-135	2	0.5	10-40	-27	-14	100	12	22	72	CK605	kg	15.95
ROS-1000V	900-1000		0	0.5	12	-74	-102	-122	-140	1.0	0.4	12-16	-30	-20	8000	5	25	73	CK605	kg	15.95
ROS-1100V	1000-1100		0	0.5	12	-80	-103	-123	-142	1.5	1.5	12-16	-26	-20	8000	5	25	73	CK605	kg	15.95
ROS-1121V	1060-1121		+2.5	1	11	-88	-111	-131	-149	0.7	0.7	8-13	-11	--	10000	5	30	74	CK605	kg	15.95
ROS-1410	850-1410		+7.0	0.5	11	-73	-99	-119	-138	15	1.0	50-80	-8	--	1000	12	25	74	CK605	kg	19.95
ROS-1500	1000-1500		+5.0	0.5	20	-79	-104	-124	-144	10	1.2	16-40	-13	--	100000	12	26	75	CK605	kg	16.95
ROS-1720	1500-1720		+7.0	0.5	12	-73	-101	-121	-141	11	1.3	28-34	-17	-10	18000	12	25	75	CK605	kg	19.95
ROS-1900	1450-1900		+7.0	0.5	20	-80	-106	-126	-146	7	0.7	22-34	-15	-10	100000	10	25	76	CK605	kg	17.95
ROS-1900V	1450-1900		+8.0	0.5	20	-78	-104	-124	-144	7	0.7	22-34	-18	-10	100000	5	28	76	CK605	kg	17.95
ROS-2000	1350-2000		+7.0	0.5	20	-75	-100	-120	-140	8	1.5	30-50	-11	--	2000	12	26	77	CK605	kg	21.95
ROS-2500	1600-2500		+6.5	0.5	14	-66	-90	-113	-133	18	5.0	30-180	-14	-8	6000	12	25	77	CK605	kg	21.95
ROS-2650	2165-2650		+6.0	0.5	10	-75	-101	-121	-141	8	1.0	27-36	-12	--	6000	12	25	78	CK605	kg	18.95
ROS-3000V	2400-3000		+9.0	0.5	22	-70	-96	-116	-136	30	1.5	20-60	-18	--	20000	5	40	78	CK605	kg	24.95

Absolute max. rating for V_{cc} and V_{tune}

Model	(V_{cc})	(V_{tune})	Model	(V_{cc})	(V_{tune})
JTOS-25	+15V	+12V	ROS-1000V, 1100V	+6V	+15V
JTOS-50	+16V	+17V	ROS-1121V	+6V	+12V
JTOS-75 thru JTOS-1025	+16V	+18V	ROS-1410	+13V	+13V
JTOS-1300	+15V	+22V	ROS-1500	+11V	+22V
JTOS-1550, 1750,1950	+13V	+22V	ROS-1720	+13V	+14V
JTOS-1650	+15V	+15V	ROS-1900	+11V	+22V
JTOS-1910	+15V	+15V	ROS-1900V	+6V	+22V
JTOS-2000	+10V	+25V	ROS-2500	+15V	+16V
JTOS-2700V	+6V	+20V	ROS-2650	+13V	+20V
JTOS-3000	+7V	+15V	Other ROS Models	+13V	+18V

PIN CONNECTIONS

see case style and outline drawings

PORT	jc	kg
RF OUT	13	10
V-CC	2	14
V-TUNE	5	2
GND EXT	1,3,4,6,7,8,9, 10,11,12,14	1,3,4,5,6,7,8,9, 11,12,13,15,16
DEMO BOARD	TB-04	TB-10

DESIGNERS KITS AVAILABLE

KIT No.	Units Per Kit	Description	Price $ Per Kit
K-JTOS1	10	1 of each: JTOS-50, 75, 100, 150, 200, 300, 400, 535, 765, 1025	149.95
K-JTOS2	7	1 of each: JTOS-50, 100, 200, 400, 535, 765, 1025	99.95
K-JTOS3	6	2 of each: JTOS-1300, 1650, 1910	114.95

OCTAVE BAND 400 to 2160MHz

MODEL◆ NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Typ.	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
JTOS-850VW	400-850		+8.0	0.5	18	-74	-96	-116	-136	6	1.6	15-80	-20	--	185	5	20	79	BK377	jc	18.95
JTOS-1000W	500-1000		+7.0	1	18	-73	-94	-114	-134	5.0	1.0	30-40	-26	-20	100	12	25	79	BK377	jc	21.95
ROS-1200W	612-1200		+10	0.5	18	-71	-97	-119	-139	9	0.45	26-68	-28	-10	20000	12	40	80	CK605	kg	24.95
ROS-1700W	770-1700		+8.0	1	24	-73	-100	-121	-140	9	0.4	26-60	-25	-13	7000	12	40	80	CK605	kg	24.95
ROS-2150VW	970-2150		+4.0	0.5	25	-70	-96	-118	-138	7	2.5	30-70	-15	--	6000	5	25	81	CK605	kg	29.95
ROS-2160W	1160-2160		+5.0	0.5	20	-70	-97	-117	-137	10	1.5	30-80	-11	--	12000	10	30	81	CK605	kg	24.95

NOTES:

◆ Aqueous washable.

A. Environmental specifications and re-flow soldering Information available in Mini-Circuits RF/IF Designer's Guide.

B. Units are non-hermetic unless otherwise noted. For details about case dimensions & finishes see "Outline Drawings & Case Style Dimensions" on pages 112 and 113.

C. Prices and Specifications subject to change without notice.
1. Absolute Maximum Supply Voltage (V_{CC}) & Tuning Voltage (V_{tune}):
2. Operating Temperature: -55°C to +85°C

Model	(V_{CC})	(V_{tune})	Model	(V_{CC})	(V_{tune})
JTOS-850VW	+6V	+20V	ROS-1700W	+15V	+30V
JTOS-1000W	+15V	+25V	ROS-2150W	+6V	+28V
ROS-1200W	+15V	+25V	ROS-2160W	+12V	+22V

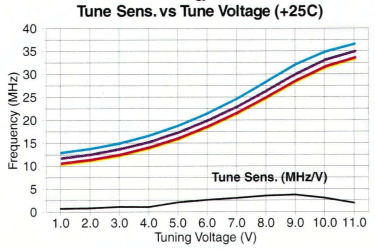
FEATURES

- Octave bandwidth range (typ.)
- Linear tuning
- Low phase noise
- Excellent harmonic suppression
- Output suitable for LO drive to mixers
- 12-V parts are usable with +15V supply for higher power output, typically 2dB
- Useful in digital cordless phones, cellular up-and-down converters, CATV distribution and set top converters, wideband frequency synthesizers, test instruments,signal generators and agile communications systems

PERFORMANCE CURVES LINEAR TUNING SURFACE MOUNT

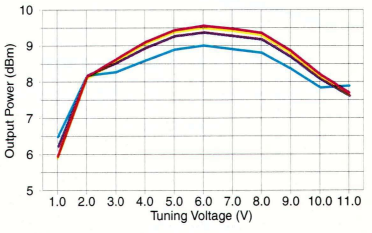
JTOS-25 Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tune Voltage (+25C)

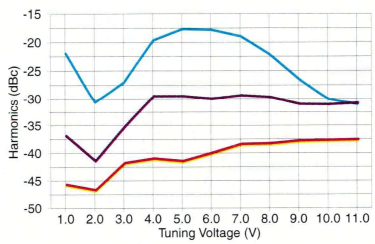


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	0.70	11.84	11.72	11.66	6.48	6.21	5.82
2.0	0.80	12.68	12.53	12.45	8.17	8.17	8.02
3.0	1.10	13.88	13.67	13.56	8.27	8.52	8.50
4.0	1.06	15.55	15.26	15.12	8.59	8.93	8.97
5.0	2.10	17.72	17.34	17.15	8.89	9.25	9.30
6.0	2.60	20.39	19.93	19.69	9.00	9.36	9.42
7.0	3.00	23.60	22.96	22.69	8.90	9.26	9.34
8.0	3.50	27.31	26.43	26.09	8.80	9.16	9.22
9.0	3.70	31.02	30.07	29.67	8.35	8.67	8.72
10.0	3.00	33.77	33.07	32.70	7.83	8.05	8.07
11.0	1.90	35.46	34.96	34.64	7.88	7.60	7.56

Power Output

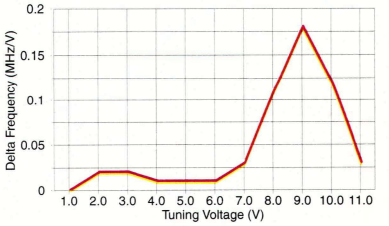


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-22.00	-36.90	-45.70	0.00
2.0	-30.70	-41.50	-46.70	0.02
3.0	-27.00	-35.30	-41.80	0.02
4.0	-19.70	-29.50	-41.00	0.01
5.0	-17.70	-29.50	-41.50	0.01
6.0	-17.80	-30.00	-40.00	0.01
7.0	-19.00	-29.40	-38.40	0.03
8.0	-22.20	-29.70	-38.30	0.11
9.0	-26.50	-31.00	-37.80	0.18
10.0	-30.10	-31.10	-37.70	0.12
11.0	-31.10	-30.80	-37.60	0.03

Frequency Pushing (Supply Voltage 12V)



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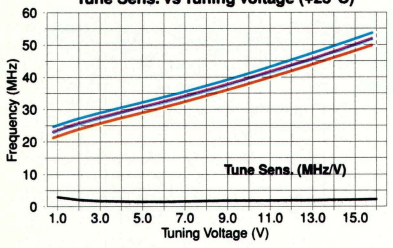
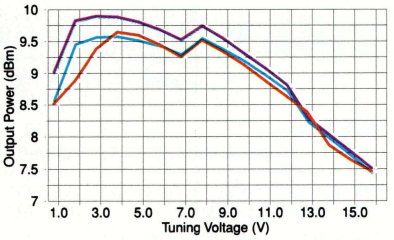
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

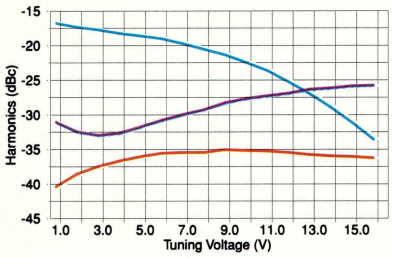


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	3.00	23.19	23.04	22.69	8.57	8.97	8.51
2.0	2.20	25.37	25.21	24.87	9.46	9.78	8.88
3.0	1.80	27.13	27.04	26.74	9.57	9.85	9.37
4.0	1.70	28.75	28.70	28.42	9.58	9.84	9.64
5.0	1.60	30.35	30.31	30.05	9.52	9.76	9.59
6.0	1.60	31.99	31.96	31.70	9.43	9.64	9.44
7.0	1.70	33.70	33.67	33.42	9.30	9.48	9.25
8.0	1.80	35.49	35.45	35.22	9.55	9.70	9.51
9.0	1.90	37.35	37.30	37.08	9.38	9.50	9.33
10.0	1.90	39.29	39.21	39.00	9.19	9.26	9.12
11.0	1.90	41.31	41.15	40.94	8.97	9.03	8.87
12.0	2.00	43.39	43.12	42.90	8.73	8.77	8.62
13.0	2.00	45.52	45.16	44.91	8.24	8.25	8.37
14.0	2.10	47.69	47.29	46.99	7.98	7.99	7.86
15.0	2.20	49.91	49.47	49.13	7.72	7.73	7.64
16.0	2.30	52.17	51.72	51.27	7.45	7.47	7.46

Power Output



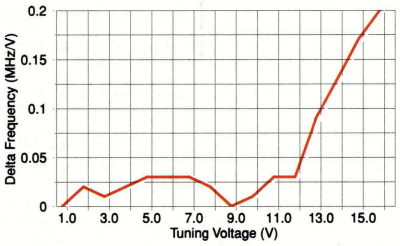
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-16.70	-31.10	-40.40
2.0	-17.30	-32.50	-38.60
3.0	-17.70	-33.00	-37.50
4.0	-18.20	-32.70	-36.70
5.0	-18.60	-31.80	-36.10
6.0	-19.00	-30.80	-35.60
7.0	-19.70	-30.00	-35.50
8.0	-20.50	-29.30	-35.50
9.0	-21.30	-28.30	-35.10
10.0	-22.40	-27.70	-35.20
11.0	-23.60	-27.30	-35.30
12.0	-25.20	-26.90	-35.50
13.0	-26.90	-26.40	-35.80
14.0	-28.90	-26.20	-36.00
15.0	-31.10	-25.90	-36.10
16.0	-33.50	-25.80	-36.30

V TUNE	FREQ. PUSHING (MHz/V)
1.0	0.00
2.0	0.02
3.0	0.01
4.0	0.02
5.0	0.03
6.0	0.03
7.0	0.03
8.0	0.02
9.0	0.00
10.0	0.01
11.0	0.03
12.0	0.03
13.0	0.09
14.0	0.13
15.0	0.17
16.0	0.20

Frequency Pushing (Supply Voltage 12V)



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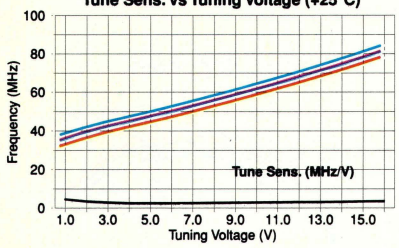
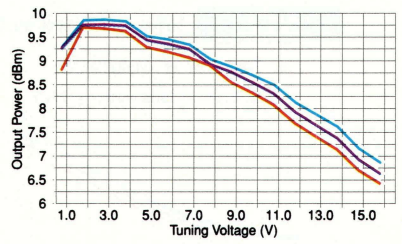
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

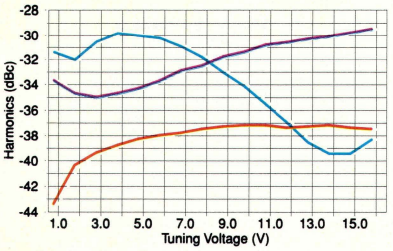


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	4.70	35.61	35.31	34.79	9.25	9.26	8.81
2.0	3.50	39.02	38.81	38.32	9.81	9.75	9.70
3.0	3.00	41.88	41.78	41.34	9.82	9.76	9.67
4.0	2.60	44.50	44.42	44.02	9.79	9.74	9.62
5.0	2.60	47.08	46.98	46.59	9.47	9.43	9.28
6.0	2.60	49.71	49.58	49.20	9.40	9.35	9.18
7.0	2.70	52.45	52.27	51.89	9.29	9.24	9.06
8.0	2.80	55.32	55.08	54.70	8.99	8.93	8.90
9.0	2.90	58.30	58.00	57.63	8.83	8.76	8.54
10.0	3.00	61.35	61.02	60.66	8.65	8.54	8.32
11.0	3.10	64.47	64.12	63.77	8.45	8.31	8.07
12.0	3.20	67.68	67.28	66.94	8.08	7.92	7.68
13.0	3.20	70.98	70.52	70.18	7.83	7.65	7.41
14.0	3.30	74.40	73.86	73.51	7.57	7.37	7.13
15.0	3.50	77.95	77.34	76.95	7.12	6.93	6.70
16.0	3.60	81.65	80.98	80.55	6.82	6.63	6.42

Power Output



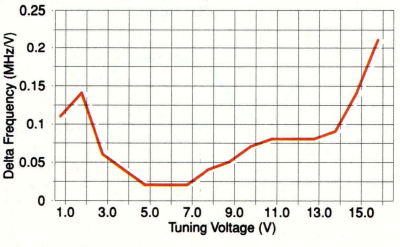
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-31.40	-33.70	-43.40
2.0	-32.00	-34.70	-40.40
3.0	-30.50	-35.00	-39.40
4.0	-29.80	-34.70	-38.80
5.0	-30.00	-34.30	-38.30
6.0	-30.20	-33.70	-38.00
7.0	-30.90	-32.90	-37.80
8.0	-31.80	-32.50	-37.50
9.0	-33.00	-31.80	-37.30
10.0	-34.10	-31.40	-37.20
11.0	-35.50	-30.80	-37.20
12.0	-36.90	-30.60	-37.40
13.0	-38.50	-30.30	-37.30
14.0	-39.40	-30.10	-37.20
15.0	-39.40	-29.80	-37.40
16.0	-38.30	-29.50	-37.50

V TUNE	FREQ. PUSHING (MHz/V)
1.0	0.11
2.0	0.14
3.0	0.06
4.0	0.04
5.0	0.02
6.0	0.02
7.0	0.02
8.0	0.04
9.0	0.05
10.0	0.07
11.0	0.08
12.0	0.08
13.0	0.08
14.0	0.09
15.0	0.14
16.0	0.21

Frequency Pushing (Supply Voltage 12V)



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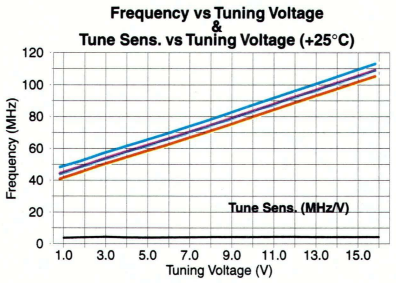
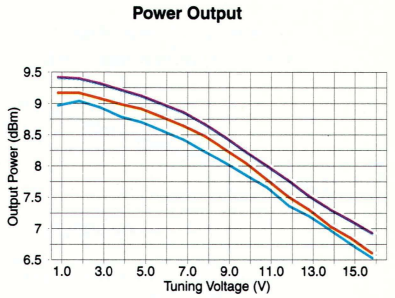
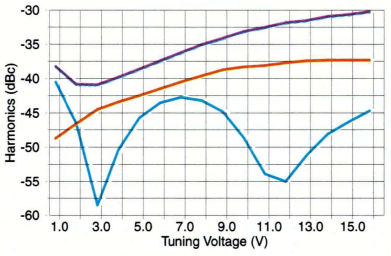
Linear Tuning - spec pg. 58

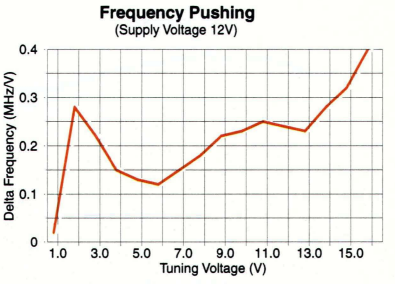


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	3.80	45.55	44.40	43.93	8.98	9.42	9.17
2.0	4.20	49.41	48.60	48.31	9.05	9.40	9.17
3.0	4.50	53.98	53.15	52.83	8.95	9.32	9.08
4.0	4.10	58.08	57.27	56.90	8.80	9.22	8.99
5.0	4.00	62.10	61.31	60.88	8.71	9.12	8.91
6.0	4.10	66.20	65.43	64.96	8.57	8.99	8.78
7.0	4.20	70.43	69.62	69.13	8.43	8.86	8.64
8.0	4.30	74.80	73.93	73.43	8.24	8.67	8.48
9.0	4.40	79.26	78.33	77.81	8.06	8.46	8.26
10.0	4.40	83.78	82.77	82.25	7.86	8.22	8.04
11.0	4.50	88.26	87.23	86.68	7.67	8.00	7.78
12.0	4.50	92.73	91.69	91.10	7.38	7.77	7.51
13.0	4.40	97.13	96.06	95.46	7.21	7.52	7.30
14.0	4.40	101.53	100.45	99.81	6.99	7.31	7.04
15.0	4.40	105.98	104.84	104.18	6.76	7.13	6.85
16.0	4.40	110.43	109.22	108.55	6.54	6.93	6.61





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-40.40	-38.20	-48.70	0.02
2.0	-46.40	-40.80	-46.60	0.28
3.0	-58.40	-40.90	-44.50	0.22
4.0	-50.30	-39.80	-43.40	0.15
5.0	-45.60	-38.60	-42.50	0.13
6.0	-43.40	-37.40	-41.50	0.12
7.0	-42.60	-36.20	-40.50	0.15
8.0	-43.10	-35.00	-39.60	0.18
9.0	-44.70	-34.10	-38.70	0.22
10.0	-48.50	-33.10	-38.30	0.23
11.0	-53.80	-32.50	-38.10	0.25
12.0	-54.90	-31.80	-37.70	0.24
13.0	-51.10	-31.50	-37.40	0.23
14.0	-48.00	-30.90	-37.30	0.28
15.0	-46.20	-30.60	-37.30	0.32
16.0	-44.60	-30.20	-37.30	0.40



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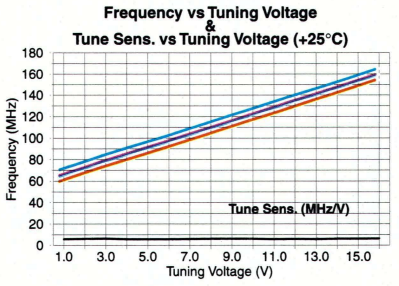
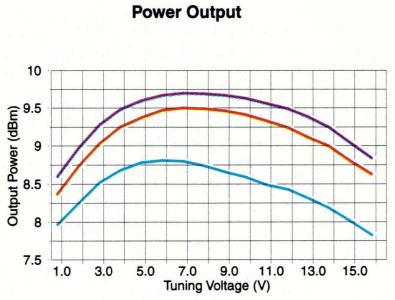
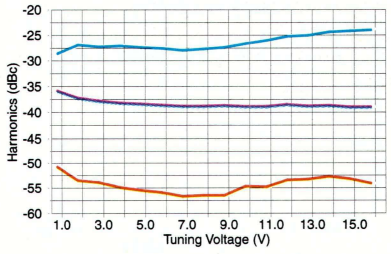
Linear Tuning - spec pg. 58

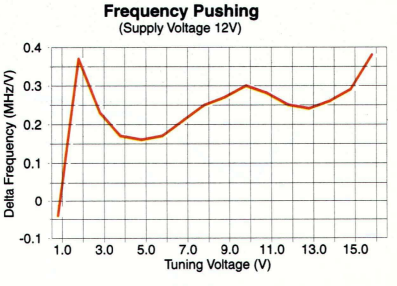


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	6.10	66.63	65.35	64.63	7.98	8.60	8.37
2.0	6.30	72.93	71.66	71.18	8.26	8.97	8.73
3.0	6.50	79.40	78.21	77.65	8.53	9.28	9.03
4.0	6.00	85.40	84.28	83.65	8.69	9.48	9.25
5.0	6.00	91.36	90.28	89.62	8.79	9.60	9.37
6.0	6.10	97.45	96.38	95.70	8.82	9.67	9.47
7.0	6.20	103.66	102.60	101.92	8.81	9.70	9.50
8.0	6.30	110.00	108.93	108.25	8.75	9.69	9.49
9.0	6.30	116.31	115.30	114.62	8.67	9.67	9.46
10.0	6.30	122.58	121.62	120.93	8.60	9.63	9.41
11.0	6.10	128.71	127.81	127.16	8.50	9.56	9.33
12.0	6.20	134.91	134.06	133.41	8.44	9.49	9.24
13.0	6.10	141.03	140.28	139.66	8.32	9.38	9.11
14.0	6.30	147.35	146.58	146.00	8.19	9.24	8.99
15.0	6.40	153.73	153.01	152.43	8.02	9.04	8.80
16.0	6.50	160.21	159.51	158.95	7.84	8.84	8.63





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-28.40	-35.80	-50.80	-0.04
2.0	-26.70	-37.20	-53.50	0.37
3.0	-27.10	-37.80	-53.90	0.23
4.0	-26.90	-38.20	-54.90	0.17
5.0	-27.20	-38.40	-55.50	0.16
6.0	-27.40	-38.60	-55.90	0.17
7.0	-27.80	-38.80	-56.70	0.21
8.0	-27.50	-38.80	-56.50	0.25
9.0	-27.20	-38.70	-56.50	0.27
10.0	-26.50	-38.90	-54.70	0.30
11.0	-25.90	-38.90	-54.80	0.28
12.0	-25.10	-38.50	-53.40	0.25
13.0	-24.90	-38.80	-53.30	0.24
14.0	-24.20	-38.70	-52.70	0.26
15.0	-24.00	-39.00	-53.20	0.29
16.0	-23.80	-39.00	-54.10	0.38



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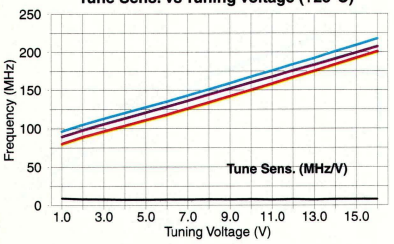
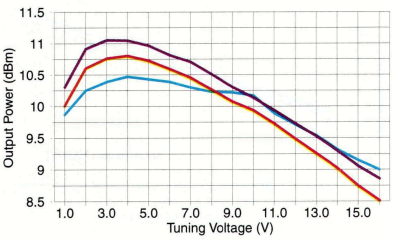
Linear Tuning - spec pg. 58

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	9.20	90.26	90.12	87.80	9.87	10.31	10.02
2.0	8.50	99.05	98.66	96.63	10.25	10.92	10.61
3.0	7.90	106.85	106.58	104.12	10.39	11.06	10.77
4.0	7.50	114.18	114.08	111.21	10.47	11.05	10.81
5.0	7.50	121.53	121.62	118.38	10.43	10.97	10.73
6.0	7.70	129.06	129.30	125.81	10.39	10.82	10.60
7.0	7.80	136.93	137.10	133.58	10.30	10.71	10.46
8.0	8.00	145.12	145.10	141.55	10.23	10.51	10.27
9.0	7.80	153.05	152.95	149.75	10.22	10.31	10.08
10.0	7.90	161.31	160.83	157.85	10.17	10.14	9.94
11.0	7.60	169.31	168.47	166.06	9.89	9.94	9.73
12.0	7.90	177.63	176.36	174.38	9.71	9.73	9.49
13.0	7.60	185.60	183.96	182.60	9.54	9.53	9.26
14.0	8.00	194.50	191.96	191.25	9.32	9.30	9.03
15.0	8.00	202.95	200.00	199.71	9.15	9.06	8.75
16.0	7.90	211.21	207.87	208.18	9.00	8.86	8.52

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

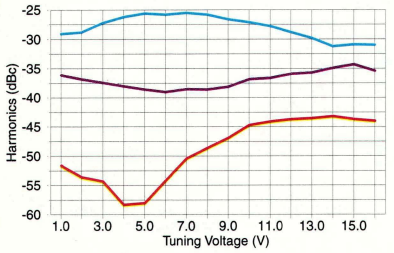


Power Output

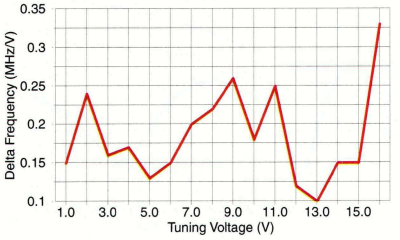


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-28.60	-36.00	-51.50	0.15
2.0	-28.30	-36.70	-53.50	0.24
3.0	-26.70	-37.30	-54.20	0.16
4.0	-25.70	-37.90	-58.20	0.17
5.0	-25.10	-38.50	-57.90	0.13
6.0	-25.30	-38.90	-54.10	0.15
7.0	-25.00	-38.40	-50.30	0.20
8.0	-25.30	-38.50	-48.50	0.22
9.0	-26.10	-38.00	-46.80	0.26
10.0	-26.60	-36.70	-44.60	0.18
11.0	-27.30	-36.50	-44.00	0.25
12.0	-28.30	-35.80	-43.60	0.12
13.0	-29.30	-35.60	-43.40	0.10
14.0	-30.70	-34.80	-43.10	0.15
15.0	-30.40	-34.20	-43.60	0.15
16.0	-30.50	-35.30	-43.90	0.33

Harmonics



Frequency Pushing
(Supply Voltage 12V)



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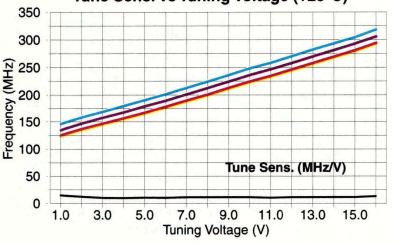
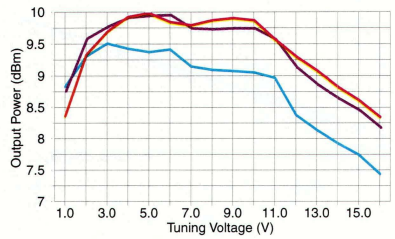
Linear Tuning - spec pg. 58

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	15.20	138.58	136.00	135.70	8.84	8.81	8.37
2.0	12.70	150.61	148.68	147.15	9.31	9.63	9.34
3.0	10.40	161.06	159.08	157.38	9.51	9.82	9.70
4.0	10.10	171.65	169.21	167.46	9.43	9.96	9.93
5.0	10.80	182.25	180.05	177.96	9.38	9.99	9.99
6.0	10.60	193.33	190.70	188.70	9.42	10.00	9.85
7.0	11.80	204.78	202.46	200.30	9.15	9.79	9.80
8.0	11.30	216.40	213.80	211.48	9.10	9.78	9.88
9.0	11.70	227.96	225.50	223.48	9.08	9.79	9.91
10.0	11.80	240.03	237.35	234.88	9.06	9.79	9.88
11.0	10.50	250.31	247.82	245.40	8.97	9.62	9.58
12.0	11.50	261.96	259.30	256.93	8.38	9.18	9.31
13.0	11.80	274.03	271.13	268.48	8.14	8.91	9.09
14.0	11.50	285.33	282.63	279.91	7.93	8.69	8.83
15.0	11.50	296.50	294.15	291.66	7.75	8.50	8.62
16.0	13.20	310.38	307.38	304.65	7.44	8.22	8.35

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

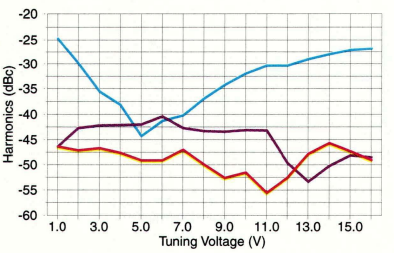


Power Output

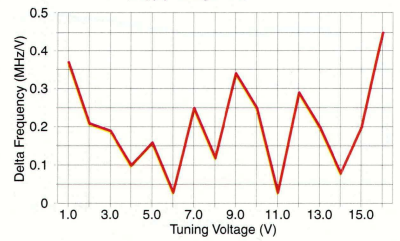


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-24.60	-46.30	-46.30	0.37
2.0	-29.70	-42.60	-47.00	0.21
3.0	-35.40	-42.10	-46.60	0.19
4.0	-38.00	-42.00	-47.50	0.10
5.0	-44.20	-41.90	-49.00	0.16
6.0	-41.20	-40.30	-49.00	0.03
7.0	-40.10	-42.60	-46.90	0.25
8.0	-36.80	-43.20	-49.80	0.12
9.0	-34.10	-43.30	-52.50	0.34
10.0	-31.80	-43.00	-51.40	0.25
11.0	-30.20	-43.10	-55.40	0.03
12.0	-30.20	-49.50	-52.40	0.29
13.0	-28.90	-53.20	-47.70	0.20
14.0	-27.90	-50.10	-45.60	0.08
15.0	-27.00	-48.00	-47.20	0.20
16.0	-26.70	-48.40	-48.90	0.45

Harmonics



Frequency Pushing
(Supply Voltage 12V)



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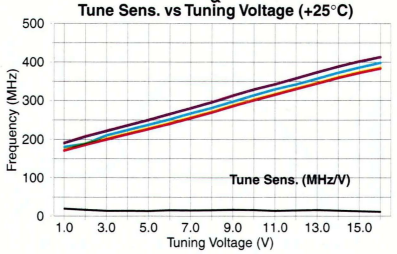
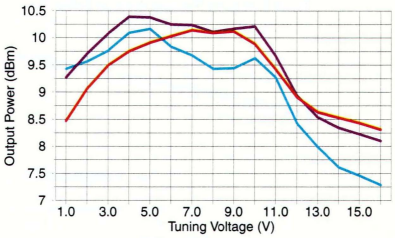
Linear Tuning - spec pg. 58

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	19.50	181.60	184.88	178.08	9.43	9.27	8.47
2.0	16.70	189.70	201.58	193.38	9.57	9.71	9.06
3.0	14.10	211.25	215.71	207.00	9.77	10.08	9.49
4.0	14.10	224.98	229.83	220.17	10.10	10.39	9.75
5.0	13.80	238.65	243.63	233.22	10.17	10.38	9.91
6.0	15.30	252.53	258.88	247.43	9.84	10.25	10.03
7.0	15.10	267.80	273.95	261.75	9.68	10.24	10.14
8.0	15.40	282.13	289.35	276.48	9.43	10.11	10.09
9.0	16.80	298.35	306.18	292.55	9.44	10.17	10.12
10.0	15.90	314.65	322.08	308.05	9.63	10.21	9.89
11.0	14.00	329.68	336.13	322.25	9.27	9.67	9.42
12.0	15.20	342.40	351.32	336.42	8.43	8.94	8.91
13.0	15.90	358.26	367.18	351.48	7.99	8.54	8.63
14.0	14.80	373.38	382.00	365.85	7.61	8.35	8.53
15.0	13.30	386.98	395.30	378.86	7.46	8.23	8.43
16.0	11.30	398.75	406.65	390.35	7.29	8.10	8.31

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

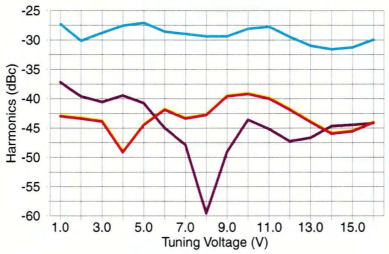


Power Output

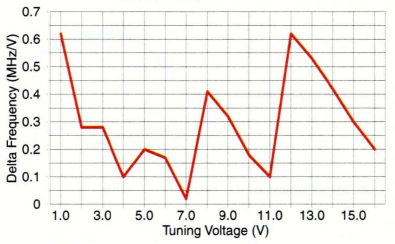


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-27.20	-37.10	-42.90	0.62
2.0	-30.10	-39.50	-43.30	0.28
3.0	-28.70	-40.50	-43.80	0.28
4.0	-27.50	-39.40	-49.10	0.10
5.0	-27.00	-40.70	-44.40	0.20
6.0	-28.50	-44.90	-41.80	0.17
7.0	-28.90	-47.80	-43.30	0.02
8.0	-29.30	-59.50	-42.70	0.41
9.0	-29.30	-49.00	-39.50	0.32
10.0	-28.00	-43.50	-39.10	0.18
11.0	-27.70	-45.10	-39.90	0.10
12.0	-29.40	-47.20	-41.80	0.62
13.0	-30.90	-46.60	-43.90	0.53
14.0	-31.50	-44.60	-45.90	0.42
15.0	-31.20	-44.40	-45.50	0.30
16.0	-29.90	-44.10	-44.00	0.20

Harmonics



Frequency Pushing
(Supply Voltage 12V)



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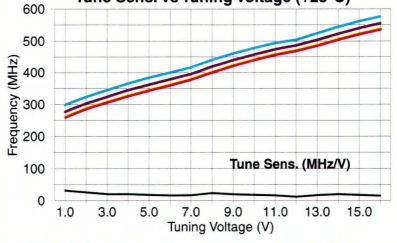
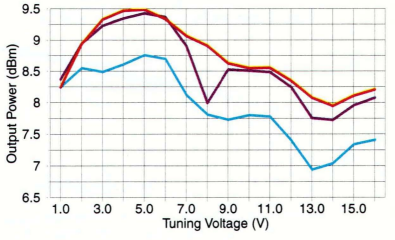
Linear Tuning - spec pg. 58

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	31.50	285.03	278.90	274.76	8.25	8.38	8.25
2.0	26.00	310.18	304.90	301.16	8.55	8.95	8.94
3.0	20.90	331.32	325.80	321.53	8.49	9.23	9.33
4.0	20.90	352.76	346.70	341.31	8.61	9.35	9.47
5.0	17.80	370.65	364.50	358.75	8.76	9.43	9.49
6.0	16.20	386.75	380.70	374.87	8.70	9.37	9.34
7.0	16.80	402.92	397.50	393.16	8.12	8.91	9.07
8.0	23.90	427.07	421.30	416.08	7.81	8.00	8.91
9.0	20.30	446.98	441.60	436.50	7.73	8.53	8.63
10.0	18.00	464.80	459.60	454.75	7.80	8.51	8.55
11.0	16.30	480.78	476.00	471.03	7.78	8.49	8.56
12.0	11.90	490.28	487.90	483.67	7.40	8.25	8.35
13.0	16.80	511.07	504.80	500.43	6.94	7.76	8.08
14.0	19.60	531.23	524.40	519.33	7.04	7.73	7.95
15.0	17.30	548.65	541.70	536.06	7.34	7.96	8.11
16.0	14.60	563.30	556.30	550.38	7.41	8.08	8.21

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

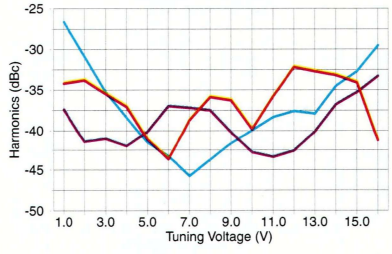


Power Output

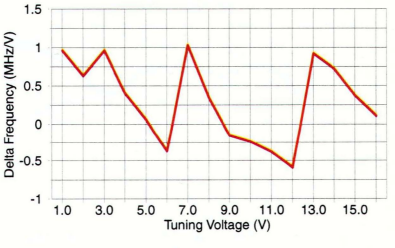


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-26.60	-37.30	-34.10	0.97
2.0	-30.90	-41.30	-33.70	0.64
3.0	-35.30	-40.90	-35.40	0.97
4.0	-38.40	-41.90	-37.00	0.41
5.0	-41.50	-40.00	-41.00	0.07
6.0	-43.30	-36.90	-43.60	-0.36
7.0	-45.70	-37.10	-38.60	1.04
8.0	-43.70	-37.40	-35.80	0.35
9.0	-41.60	-40.10	-36.20	-0.14
10.0	-39.90	-42.70	-39.70	-0.23
11.0	-38.30	-43.30	-35.70	-0.37
12.0	-37.60	-42.50	-32.10	-0.58
13.0	-37.90	-40.00	-32.60	0.93
14.0	-34.50	-36.70	-33.10	0.73
15.0	-32.70	-35.20	-34.00	0.38
16.0	-29.50	-33.20	-41.10	0.12

Harmonics



Frequency Pushing
(Supply Voltage 12V)



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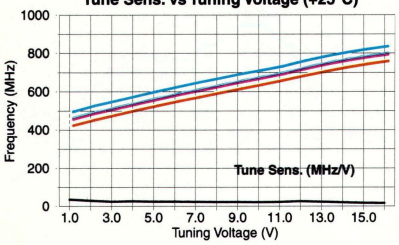
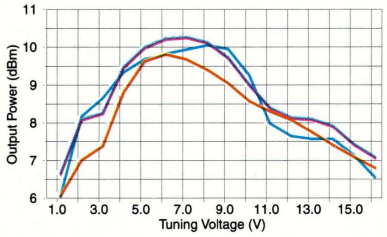
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

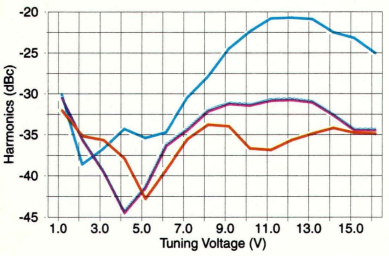


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	35.00	465.25	458.58	452.66	6.03	6.65	6.07
2.0	29.60	495.97	488.18	481.77	8.15	8.08	7.02
3.0	24.30	520.33	512.46	506.55	8.63	8.25	7.39
4.0	25.30	545.93	537.73	531.95	9.31	9.46	8.82
5.0	24.30	570.77	562.06	556.06	9.66	9.98	9.64
6.0	23.80	594.83	585.85	579.35	9.80	10.21	9.82
7.0	22.70	617.68	608.52	601.52	9.91	10.25	9.69
8.0	21.90	640.03	630.40	623.18	10.03	10.11	9.41
9.0	21.70	661.98	652.12	644.62	9.92	9.71	9.06
10.0	20.80	681.98	672.95	665.68	9.24	9.00	8.59
11.0	21.90	702.20	694.83	688.36	7.96	8.39	8.31
12.0	25.50	728.47	720.38	712.66	7.62	8.13	8.09
13.0	23.00	752.52	743.41	734.83	7.54	8.09	7.76
14.0	19.80	772.63	763.22	754.73	7.54	7.90	7.41
15.0	17.20	789.40	780.43	772.20	7.12	7.42	7.10
16.0	15.50	804.72	795.96	787.93	6.53	7.07	6.81

Power Output

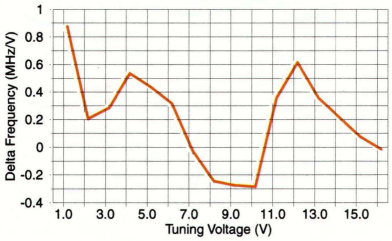


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-30.20	-30.50	-32.00	0.88
2.0	-38.70	-35.60	-35.10	0.21
3.0	-36.80	-39.50	-35.60	0.29
4.0	-34.40	-44.40	-37.80	0.54
5.0	-35.50	-41.40	-42.70	0.44
6.0	-34.80	-36.30	-39.20	0.32
7.0	-30.60	-34.40	-35.50	-0.02
8.0	-28.00	-32.10	-33.70	-0.24
9.0	-24.60	-31.20	-33.90	-0.27
10.0	-22.50	-31.40	-36.60	-0.28
11.0	-20.90	-30.80	-36.80	0.36
12.0	-20.80	-30.70	-35.60	0.62
13.0	-21.00	-31.00	-34.80	0.36
14.0	-22.60	-32.60	-34.10	0.22
15.0	-23.30	-34.40	-34.70	0.08
16.0	-25.10	-34.40	-34.80	-0.01

Frequency Pushing
(Supply Voltage 12V)



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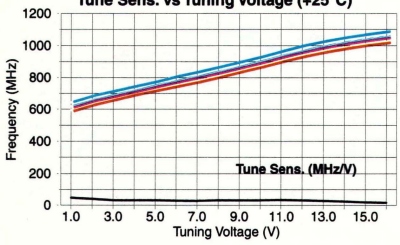
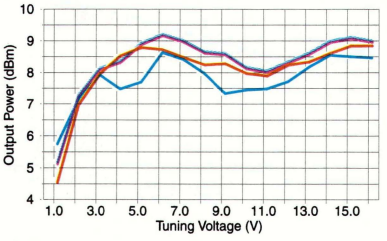
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

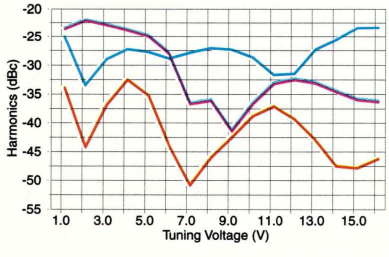


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	48.00	626.90	616.50	609.08	5.72	5.15	4.56
2.0	39.90	667.15	656.40	649.63	7.12	7.25	6.98
3.0	30.60	697.26	686.95	681.65	7.91	8.11	7.97
4.0	30.30	725.92	717.23	711.85	7.45	8.34	8.55
5.0	31.20	755.70	748.42	739.97	7.68	8.91	8.81
6.0	29.00	788.73	777.42	766.42	8.61	9.19	8.74
7.0	27.70	816.86	805.13	793.90	8.39	8.99	8.50
8.0	30.30	846.70	835.47	824.70	7.95	8.64	8.27
9.0	31.90	878.96	867.33	856.78	7.31	8.58	8.30
10.0	31.00	910.30	898.35	888.22	7.42	8.15	8.00
11.0	34.40	946.17	932.78	922.00	7.46	8.03	7.92
12.0	31.90	979.23	964.68	952.73	7.69	8.32	8.26
13.0	27.50	1007.05	992.13	978.85	8.15	8.60	8.36
14.0	23.00	1029.60	1015.10	1001.43	8.52	8.97	8.63
15.0	18.90	1048.83	1034.03	1020.18	8.48	9.09	8.86
16.0	16.90	1065.93	1050.93	1036.63	8.44	8.98	8.87

Power Output

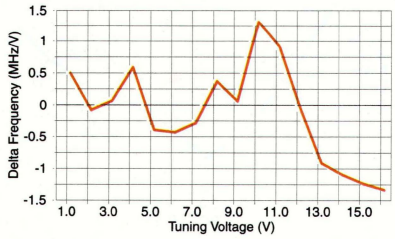


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-25.20	-23.50	-33.80	0.51
2.0	-33.60	-21.90	-44.10	-0.07
3.0	-29.10	-22.80	-36.70	0.08
4.0	-27.40	-23.80	-32.40	0.60
5.0	-27.90	-24.90	-35.10	-0.38
6.0	-29.00	-28.00	-43.80	-0.42
7.0	-28.00	-36.60	-50.70	-0.27
8.0	-27.20	-36.00	-45.90	0.38
9.0	-27.50	-41.30	-42.40	0.07
10.0	-28.80	-36.60	-38.70	1.33
11.0	-31.80	-33.10	-37.00	0.92
12.0	-31.60	-32.40	-39.20	-0.05
13.0	-27.50	-33.00	-42.80	-0.90
14.0	-25.70	-34.50	-47.40	-1.08
15.0	-23.60	-35.90	-47.70	-1.22
16.0	-23.50	-36.20	-46.10	-1.32

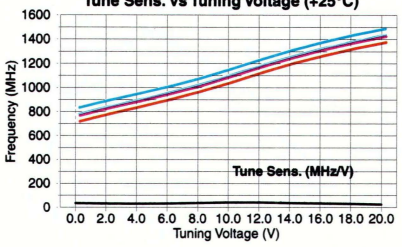
Frequency Pushing
(Supply Voltage 12V)



JTOS-1300

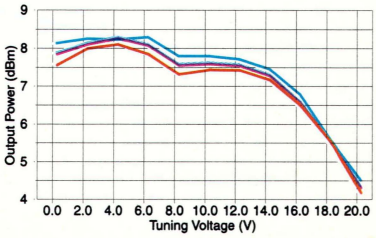
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

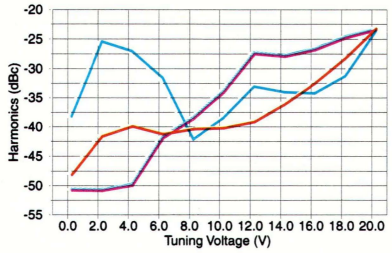


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	34.65	786.58	775.04	769.41	7.99	7.87	7.65
2.0	30.99	848.61	838.39	832.97	8.11	8.13	8.09
4.0	28.07	904.82	896.40	891.43	8.09	8.29	8.20
6.0	31.26	965.67	958.01	953.12	8.15	8.10	7.94
8.0	35.13	1033.65	1025.80	1020.79	7.65	7.58	7.41
10.0	39.22	1110.96	1103.08	1098.09	7.65	7.62	7.53
12.0	40.91	1192.50	1184.14	1178.93	7.57	7.57	7.52
14.0	35.31	1267.41	1258.92	1253.19	7.31	7.30	7.26
16.0	32.17	1332.76	1324.34	1318.94	6.64	6.59	6.59
18.0	28.85	1390.63	1382.10	1376.54	5.44	5.54	5.62
20.0	24.55	1441.92	1433.14	1427.03	4.37	4.34	4.28

Power Output

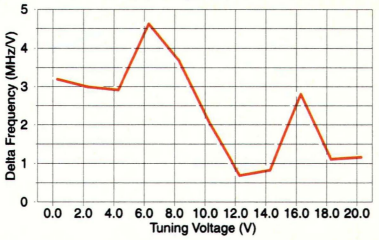


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.0	-38.30	-50.63	-47.97	3.22
2.0	-25.52	-50.69	-41.52	3.02
4.0	-27.11	-49.78	-39.78	2.94
6.0	-31.63	-41.80	-41.13	4.65
8.0	-42.24	-38.41	-40.24	3.71
10.0	-38.57	-33.91	-40.07	2.08
12.0	-33.15	-27.31	-38.98	0.72
14.0	-34.11	-27.77	-35.94	0.86
16.0	-34.31	-26.65	-32.31	2.83
18.0	-31.33	-24.66	-27.99	1.14
20.0	-23.79	-23.29	-23.13	1.19

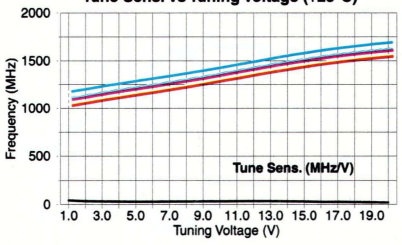
Frequency Pushing (Supply Voltage 12V)



JTOS-1550

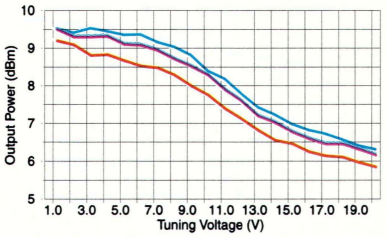
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

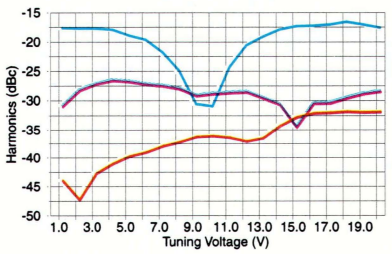


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	39.98	1118.90	1103.98	1092.24	9.52	9.53	9.23
2.0	31.91	1150.30	1135.89	1124.60	9.40	9.33	9.12
3.0	29.25	1179.20	1165.15	1153.97	9.52	9.33	8.84
4.0	27.70	1206.59	1192.85	1181.89	9.44	9.34	8.86
5.0	27.25	1233.47	1220.10	1209.33	9.34	9.13	8.70
6.0	27.38	1260.46	1247.47	1236.92	9.35	9.11	8.56
7.0	27.82	1287.85	1275.30	1265.14	9.15	8.97	8.51
8.0	28.58	1316.06	1303.88	1294.12	9.03	8.74	8.32
9.0	29.69	1345.45	1333.57	1324.15	8.81	8.55	8.03
10.0	30.92	1375.95	1364.49	1355.48	8.39	8.31	7.78
11.0	31.71	1407.43	1396.20	1387.44	8.17	7.92	7.42
12.0	32.14	1439.65	1428.34	1419.55	7.78	7.62	7.15
13.0	31.51	1471.30	1459.85	1450.98	7.41	7.22	6.84
14.0	29.64	1501.26	1489.50	1480.49	7.22	7.05	6.58
15.0	27.52	1529.19	1517.02	1507.70	6.97	6.80	6.49
16.0	25.17	1554.76	1542.19	1532.60	6.81	6.62	6.28
17.0	22.78	1577.85	1564.96	1555.13	6.71	6.48	6.17
18.0	20.52	1598.81	1585.48	1575.38	6.56	6.48	6.14
19.0	18.65	1617.95	1604.13	1593.71	6.40	6.34	6.00
20.0	17.07	1635.43	1621.20	1610.46	6.30	6.19	5.88

Power Output

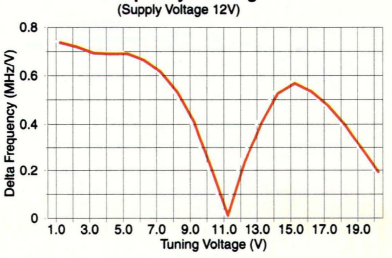


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-17.72	-30.82	-43.80	0.74
2.0	-17.79	-28.14	-47.14	0.72
3.0	-17.77	-27.03	-42.63	0.70
4.0	-17.98	-26.44	-40.90	0.70
5.0	-19.00	-26.64	-39.61	0.70
6.0	-19.73	-27.11	-38.89	0.67
7.0	-21.86	-27.35	-37.74	0.62
8.0	-24.99	-27.88	-37.06	0.54
9.0	-30.67	-29.03	-36.11	0.41
10.0	-31.00	-28.70	-35.92	0.22
11.0	-24.37	-28.55	-36.21	0.02
12.0	-20.64	-28.40	-36.93	0.24
13.0	-19.16	-29.45	-36.34	0.41
14.0	-17.95	-30.54	-34.07	0.53
15.0	-17.37	-34.35	-32.64	0.57
16.0	-17.32	-30.33	-31.93	0.54
17.0	-17.12	-30.28	-31.86	0.48
18.0	-16.64	-29.46	-31.68	0.40
19.0	-17.12	-28.69	-31.79	0.30
20.0	-17.64	-28.32	-31.73	0.20

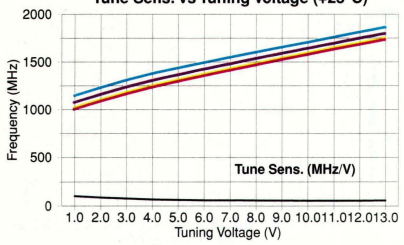
Frequency Pushing (Supply Voltage 12V)



JTOS-1650

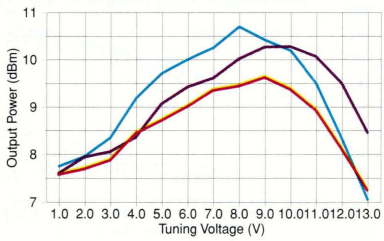
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

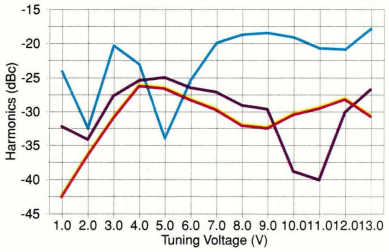


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	101.10	1106.73	1085.63	1067.20	7.77	7.62	7.59
2.0	85.99	1190.49	1170.27	1151.71	7.98	7.96	7.71
3.0	77.73	1267.65	1246.62	1228.18	8.37	8.07	7.89
4.0	67.82	1336.40	1315.12	1297.10	9.21	8.38	8.46
5.0	61.47	1394.36	1375.44	1358.98	9.74	9.09	8.73
6.0	58.97	1452.60	1434.07	1417.73	10.03	9.44	9.03
7.0	57.55	1508.07	1490.42	1475.01	10.28	9.63	9.37
8.0	56.98	1561.32	1546.49	1531.62	10.72	10.04	9.46
9.0	55.89	1615.27	1601.08	1587.11	10.44	10.29	9.64
10.0	54.81	1665.66	1652.87	1641.11	10.22	10.30	9.39
11.0	55.14	1719.10	1706.95	1695.58	9.52	10.09	8.95
12.0	54.98	1772.48	1758.82	1747.06	8.35	9.52	8.13
13.0	56.31	1822.76	1809.17	1797.64	7.08	8.48	7.27

Power Output

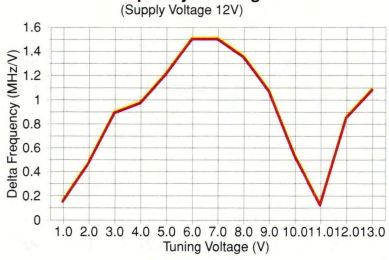


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-23.86	-32.03	-42.36	0.16
2.0	-32.33	-33.99	-36.33	0.48
3.0	-20.17	-27.50	-30.83	0.90
4.0	-22.89	-25.23	-26.06	0.98
5.0	-33.78	-24.78	-26.45	1.22
6.0	-25.12	-26.29	-28.12	1.51
7.0	-19.76	-26.92	-29.59	1.51
8.0	-18.55	-28.89	-31.89	1.36
9.0	-18.30	-29.47	-32.30	1.08
10.0	-18.97	-38.64	-30.30	0.54
11.0	-20.56	-39.90	-29.40	0.13
12.0	-20.72	-29.88	-28.05	0.86
13.0	-17.70	-26.53	-30.53	1.09

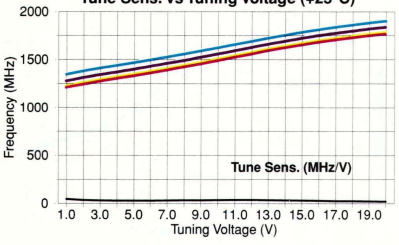
Frequency Pushing (Supply Voltage 12V)



JTOS-1750

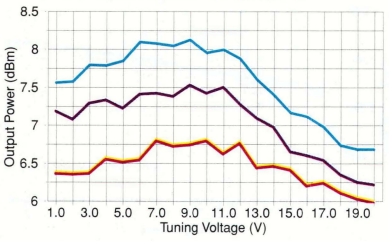
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

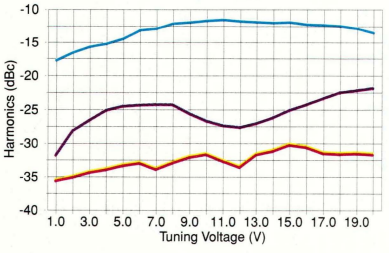


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	44.34	1305.96	1291.15	1275.92	7.58	7.20	6.38
2.0	34.26	1339.70	1325.40	1310.55	7.59	7.09	6.37
3.0	30.62	1369.82	1356.02	1341.33	7.81	7.31	6.38
4.0	29.03	1398.48	1385.05	1370.41	7.80	7.35	6.57
5.0	28.58	1426.88	1413.63	1398.86	7.86	7.24	6.53
6.0	28.99	1455.67	1442.62	1427.70	8.11	7.43	6.56
7.0	29.79	1485.25	1472.41	1457.39	8.09	7.44	6.81
8.0	30.99	1516.06	1503.40	1488.20	8.06	7.40	6.74
9.0	32.62	1548.50	1536.03	1520.65	8.14	7.55	6.76
10.0	33.93	1582.05	1569.96	1554.54	7.97	7.44	6.81
11.0	34.75	1616.27	1604.70	1589.35	8.01	7.52	6.64
12.0	34.54	1650.24	1639.25	1624.15	7.89	7.30	6.78
13.0	33.55	1683.56	1672.80	1657.90	7.62	7.11	6.46
14.0	32.04	1715.36	1704.84	1689.91	7.42	6.99	6.48
15.0	29.92	1745.26	1734.76	1719.68	7.18	6.67	6.43
16.0	27.55	1772.62	1762.31	1747.11	7.13	6.62	6.22
17.0	25.22	1797.95	1787.53	1771.91	6.99	6.56	6.26
18.0	23.04	1821.20	1810.57	1794.62	6.75	6.37	6.13
19.0	21.11	1842.49	1831.68	1815.49	6.70	6.27	6.05
20.0	19.30	1861.91	1850.98	1834.26	6.70	6.24	6.00

Power Output

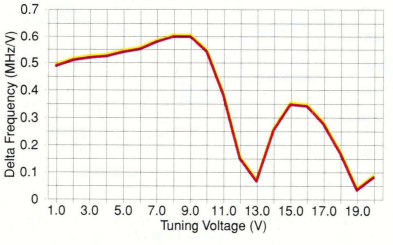


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-17.61	-31.61	-35.45	0.49
2.0	-16.45	-27.95	-34.95	0.52
3.0	-15.55	-26.39	-34.22	0.52
4.0	-15.11	-24.95	-33.78	0.53
5.0	-14.34	-24.34	-33.17	0.55
6.0	-12.98	-24.14	-32.81	0.56
7.0	-12.73	-24.07	-33.73	0.58
8.0	-11.94	-24.10	-32.77	0.61
9.0	-11.75	-25.42	-31.92	0.61
10.0	-11.48	-26.48	-31.48	0.55
11.0	-11.33	-27.16	-32.50	0.39
12.0	-11.59	-27.43	-33.43	0.16
13.0	-11.69	-26.85	-31.52	0.07
14.0	-11.80	-25.97	-30.97	0.26
15.0	-11.71	-24.88	-30.04	0.35
16.0	-12.07	-24.07	-30.40	0.35
17.0	-12.15	-23.15	-31.31	0.28
18.0	-12.28	-22.28	-31.45	0.18
19.0	-12.66	-21.99	-31.33	0.04
20.0	-13.34	-21.67	-31.50	0.09

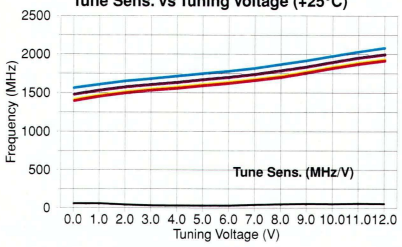
Frequency Pushing (Supply Voltage 12V)



JTOS-1910

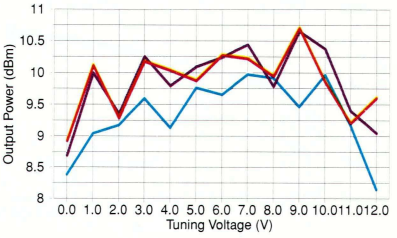
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

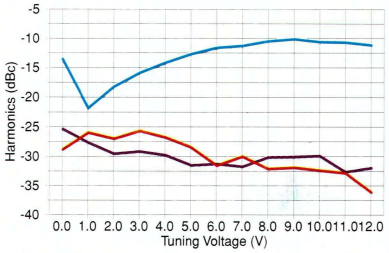


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	57.94	1508.26	1491.52	1476.39	8.40	8.71	8.94
1.0	57.94	1554.05	1544.82	1537.31	9.06	10.01	10.13
2.0	41.34	1598.97	1588.83	1577.63	9.19	9.37	9.30
3.0	34.08	1627.74	1619.79	1612.58	9.61	10.27	10.19
4.0	30.08	1660.60	1649.47	1639.71	9.15	9.81	10.05
5.0	28.94	1692.32	1683.38	1673.90	9.78	10.11	9.89
6.0	31.95	1725.22	1714.51	1704.68	9.67	10.26	10.29
7.0	38.95	1762.37	1753.12	1742.86	9.99	10.46	10.24
8.0	47.81	1813.99	1800.67	1784.91	9.93	9.80	9.96
9.0	53.22	1861.00	1849.10	1839.73	9.48	10.67	10.72
10.0	50.09	1920.01	1911.38	1901.14	9.98	10.39	9.87
11.0	55.01	1978.64	1967.46	1953.64	9.19	9.42	9.22
12.0	53.58	2028.35	2012.22	1998.63	8.16	9.07	9.62

Power Output



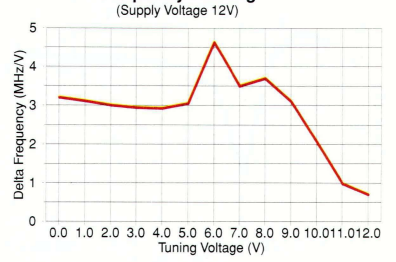
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-13.42	-25.26	-28.76
1.0	-21.73	-27.56	-25.90
2.0	-18.12	-29.45	-26.95
3.0	-15.76	-29.09	-25.59
4.0	-14.04	-29.71	-26.71
5.0	-12.56	-31.40	-28.40
6.0	-11.49	-31.16	-31.49
7.0	-11.13	-31.63	-29.96
8.0	-10.37	-30.03	-32.03
9.0	-9.97	-29.97	-31.80
10.0	-10.47	-29.80	-32.30
11.0	-10.56	-32.56	-32.73
12.0	-11.02	-31.85	-36.02

FREQ PUSHING (MHz/V)
3.22
3.13
3.02
2.96
2.94
3.07
4.65
3.51
3.71
3.12
2.08
1.00
0.72

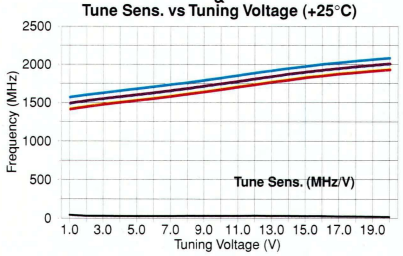
Frequency Pushing (Supply Voltage 12V)



JTOS-1950

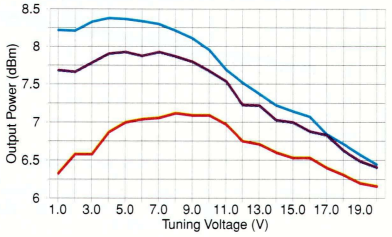
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

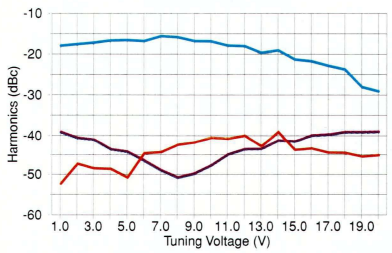


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	42.21	1510.88	1495.18	1484.27	8.23	7.69	6.33
2.0	31.71	1542.16	1526.89	1516.16	8.22	7.67	6.58
3.0	28.16	1569.99	1555.05	1544.31	8.34	7.79	6.58
4.0	26.43	1596.06	1581.47	1570.83	8.39	7.91	6.87
5.0	25.97	1621.88	1607.44	1596.82	8.38	7.93	7.00
6.0	26.41	1648.11	1633.84	1623.22	8.35	7.88	7.04
7.0	27.19	1674.97	1661.03	1650.50	8.31	7.93	7.06
8.0	28.29	1703.08	1689.32	1678.87	8.22	7.87	7.12
9.0	29.79	1732.82	1719.11	1708.72	8.12	7.80	7.09
10.0	31.47	1763.90	1750.58	1740.13	7.96	7.68	7.09
11.0	31.91	1795.45	1782.48	1772.34	7.70	7.54	6.97
12.0	32.16	1827.94	1814.64	1804.53	7.53	7.23	6.75
13.0	31.36	1858.67	1846.00	1836.23	7.38	7.22	6.71
14.0	29.99	1888.97	1876.00	1865.65	7.23	7.03	6.60
15.0	27.00	1916.61	1902.99	1893.37	7.15	7.00	6.53
16.0	26.13	1942.09	1929.12	1918.45	7.08	6.88	6.53
17.0	23.17	1965.54	1952.29	1942.16	6.85	6.83	6.40
18.0	21.97	1987.65	1974.25	1963.35	6.72	6.63	6.31
19.0	19.70	2008.17	1993.95	1982.65	6.58	6.49	6.20
20.0	18.65	2027.10	2012.60	2000.77	6.45	6.41	6.16

Power Output



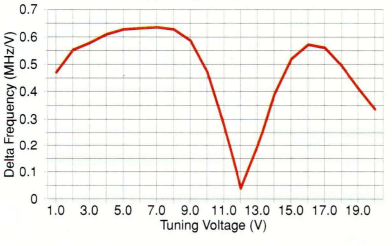
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-17.90	-39.11	-52.41
2.0	-17.47	-40.59	-47.38
3.0	-17.11	-41.06	-48.54
4.0	-16.56	-43.61	-48.65
5.0	-16.48	-44.27	-50.89
6.0	-16.74	-46.50	-44.75
7.0	-15.55	-48.99	-44.46
8.0	-15.78	-50.83	-42.47
9.0	-16.76	-49.83	-41.83
10.0	-16.77	-47.78	-40.62
11.0	-17.81	-44.97	-40.84
12.0	-17.98	-43.60	-40.05
13.0	-19.61	-43.54	-42.83
14.0	-18.96	-41.30	-39.15
15.0	-21.26	-41.53	-43.82
16.0	-21.67	-39.98	-43.40
17.0	-22.72	-39.76	-44.53
18.0	-23.66	-39.10	-44.56
19.0	-27.97	-39.12	-45.52
20.0	-29.05	-39.02	-45.19

FREQ. PUSHING (MHz/V)
0.47
0.55
0.58
0.61
0.63
0.63
0.63
0.63
0.59
0.47
0.28
0.04
0.20
0.39
0.52
0.57
0.56
0.50
0.41
0.34

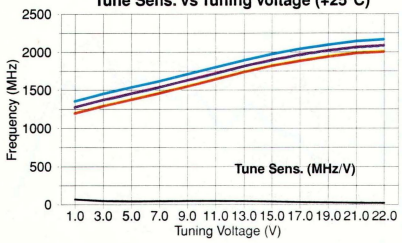
Frequency Pushing (Supply Voltage 12V)



JTOS-2000

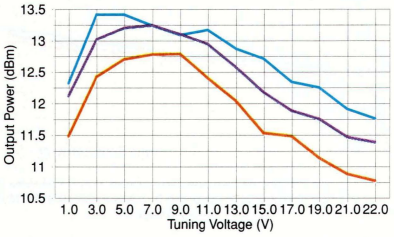
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

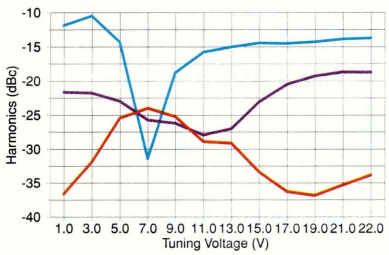


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	69.23	1284.71	1266.03	1250.18	12.32	12.11	11.47
3.0	46.00	1384.20	1364.13	1346.86	13.41	13.01	12.41
5.0	41.55	1464.49	1446.30	1429.90	13.41	13.20	12.69
7.0	43.22	1547.52	1530.72	1514.72	13.24	13.24	12.77
9.0	45.84	1640.53	1621.98	1604.43	13.09	13.10	12.78
11.0	46.00	1733.86	1715.81	1699.63	13.17	12.94	12.39
13.0	44.21	1823.35	1807.46	1791.67	12.87	12.57	12.03
15.0	40.65	1905.18	1890.65	1875.57	12.71	12.17	11.52
17.0	32.90	1974.74	1958.16	1941.17	12.34	11.88	11.47
19.0	25.83	2030.28	2015.46	1999.05	12.25	11.75	11.13
21.0	22.06	2078.26	2060.55	2041.93	11.91	11.46	10.87
22.0	20.61	2099.05	2081.16	2061.53	11.76	11.38	10.76

Power Output

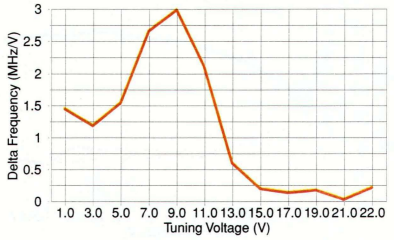


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-11.92	-21.75	-36.75	1.43
3.0	-10.52	-21.85	-32.02	1.17
5.0	-14.40	-23.07	-25.57	1.53
7.0	-31.46	-25.80	-24.13	2.65
9.0	-18.84	-26.27	-25.34	2.97
11.0	-15.84	-28.01	-29.01	2.08
13.0	-15.06	-27.06	-29.23	0.59
15.0	-14.49	-23.16	-33.49	0.18
17.0	-14.56	-20.56	-36.39	0.12
19.0	-14.32	-19.32	-36.98	0.16
21.0	-13.93	-18.76	-35.43	0.02
22.0	-13.80	-18.80	-33.96	0.20

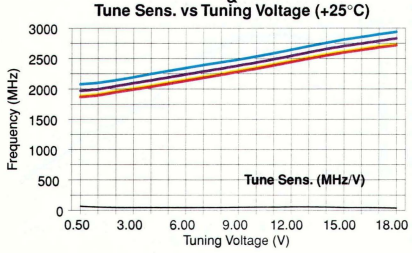
Frequency Pushing
(Supply Voltage 8V)



JTOS-2700V

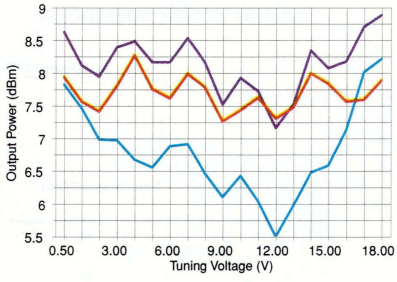
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

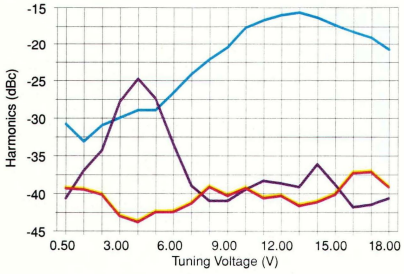


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	66.10	1984.06	1962.28	1944.74	7.82	8.62	7.93
1.00	54.18	2008.02	1989.36	1973.98	7.46	8.11	7.56
2.00	48.85	2049.84	2038.86	2024.40	6.98	7.94	7.41
3.00	47.16	2100.28	2086.36	2070.81	6.97	8.39	7.80
4.00	47.11	2150.89	2133.24	2116.63	6.67	8.48	8.26
5.00	47.96	2201.79	2181.80	2164.34	6.55	8.16	7.75
6.00	47.57	2249.20	2229.07	2211.64	6.88	8.16	7.61
7.00	48.13	2296.32	2277.25	2259.79	6.91	8.53	7.98
8.00	48.27	2342.62	2325.22	2308.21	6.46	8.16	7.78
9.00	49.53	2390.20	2374.59	2358.09	6.10	7.52	7.26
10.00	52.33	2439.98	2426.07	2409.77	6.42	7.92	7.43
11.00	54.22	2493.19	2480.08	2463.52	6.04	7.72	7.62
12.00	56.14	2551.46	2536.17	2518.13	5.50	7.16	7.30
13.00	55.90	2609.00	2592.33	2572.37	5.97	7.52	7.47
14.00	53.23	2665.27	2646.24	2623.82	6.47	8.34	7.99
15.00	48.60	2716.42	2695.75	2671.71	6.58	8.07	7.83
16.00	44.11	2762.75	2740.74	2715.56	7.13	8.17	7.56
17.00	40.89	2806.72	2782.42	2756.07	8.01	8.70	7.59
18.00	37.51	2846.39	2820.83	2793.54	8.21	8.88	7.88

Power Output

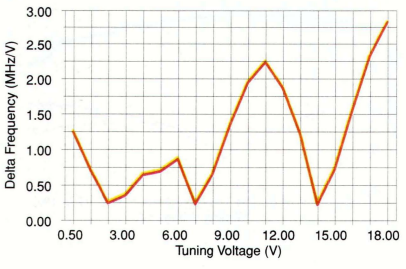


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-30.84	-40.67	-39.34	1.24
1.00	-33.16	-37.00	-39.50	0.70
2.00	-31.00	-34.33	-40.17	0.24
3.00	-30.00	-27.84	-43.00	0.35
4.00	-29.00	-24.83	-43.83	0.64
5.00	-29.00	-27.50	-42.50	0.69
6.00	-26.66	-33.50	-42.50	0.86
7.00	-24.17	-39.00	-41.34	0.23
8.00	-22.17	-41.00	-39.17	0.66
9.00	-20.50	-41.00	-40.34	1.35
10.00	-17.66	-39.50	-39.33	1.94
11.00	-16.66	-38.33	-40.66	2.23
12.00	-16.00	-38.67	-40.34	1.86
13.00	-15.66	-39.16	-41.66	1.21
14.00	-16.34	-36.17	-41.17	0.22
15.00	-17.33	-38.83	-40.17	0.72
16.00	-18.33	-41.83	-37.33	1.55
17.00	-19.17	-41.50	-37.17	2.32
18.00	-20.83	-40.67	-39.17	2.82

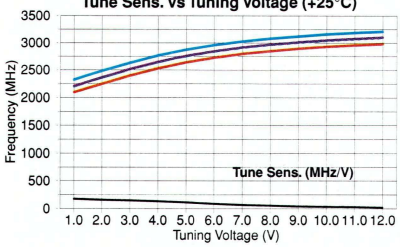
Frequency Pushing
(Supply Voltage 5V)



JTOS-3000

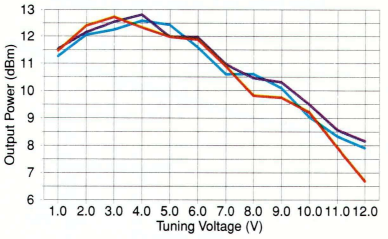
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

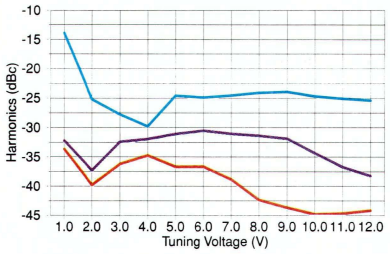


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	176.12	2225.99	2198.67	2174.92	11.25	11.52	11.44
2.0	157.23	2384.50	2355.89	2330.30	12.05	12.15	12.37
3.0	149.91	2532.44	2505.80	2480.24	12.25	12.53	12.70
4.0	134.49	2667.36	2640.29	2613.28	12.58	12.79	12.31
5.0	110.75	2777.08	2751.04	2722.31	12.42	11.97	11.96
6.0	85.80	2861.78	2836.84	2808.04	11.59	11.96	11.85
7.0	68.55	2926.73	2905.39	2876.59	10.59	10.95	10.86
8.0	55.21	2981.93	2960.60	2929.42	10.60	10.44	9.79
9.0	43.80	3022.95	3004.40	2975.14	10.09	10.29	9.72
10.0	35.45	3060.48	3039.86	3009.84	9.03	9.48	9.18
11.0	30.39	3088.57	3070.25	3037.86	8.33	8.54	7.90
12.0	21.74	3108.80	3091.99	3062.02	7.90	8.14	6.65

Power Output



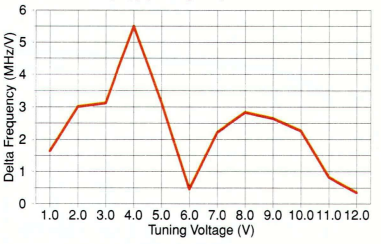
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-14.00	-32.33	-33.83
2.0	-25.29	-37.45	-39.95
3.0	-27.86	-32.52	-36.36
4.0	-29.90	-32.06	-34.90
5.0	-24.68	-31.18	-36.85
6.0	-24.97	-30.63	-36.80
7.0	-24.65	-31.15	-38.99
8.0	-24.18	-31.51	-42.51
9.0	-24.00	-32.00	-43.83
10.0	-24.79	-34.46	-44.96
11.0	-25.16	-36.83	-44.83
12.0	-25.50	-38.33	-44.33

V TUNE	FREQ. PUSHING (MHz/V)
1.0	1.61
2.0	2.98
3.0	3.09
4.0	5.47
5.0	3.11
6.0	0.43
7.0	2.19
8.0	2.80
9.0	2.62
10.0	2.24
11.0	0.80
12.0	0.32

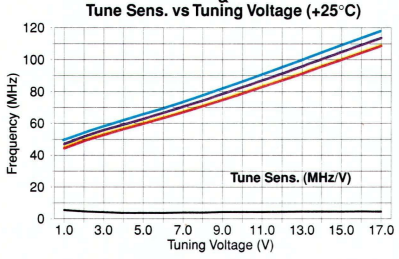
Frequency Pushing
(Supply Voltage 5V)



ROS-100

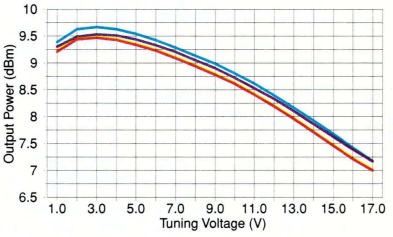
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

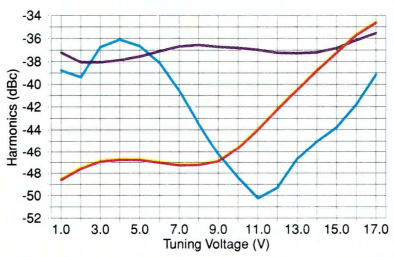


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	5.57	48.58	46.66	44.86	9.33	9.34	9.20
2.00	4.54	53.06	51.20	49.41	9.57	9.53	9.43
3.00	4.10	57.22	55.30	53.31	9.61	9.57	9.46
4.00	3.58	60.99	58.88	56.83	9.57	9.55	9.42
5.00	3.65	64.77	62.53	60.35	9.49	9.48	9.33
6.00	3.65	68.48	66.18	63.87	9.37	9.37	9.22
7.00	3.90	72.45	70.08	67.58	9.23	9.24	9.08
8.00	3.90	76.61	73.98	71.42	9.08	9.09	8.93
9.00	4.22	80.96	78.21	75.33	8.93	8.94	8.77
10.00	4.22	85.38	82.43	79.36	8.75	8.76	8.60
11.00	4.29	89.79	86.72	83.52	8.56	8.57	8.40
12.00	4.35	94.34	91.07	87.68	8.34	8.37	8.18
13.00	4.42	98.88	95.49	91.90	8.11	8.14	7.95
14.00	4.48	103.49	99.97	96.19	7.87	7.90	7.70
15.00	4.48	108.10	104.45	100.54	7.62	7.66	7.45
16.00	4.54	112.70	108.99	104.90	7.37	7.43	7.21
17.00	4.42	117.18	113.41	109.25	7.12	7.21	6.99

Power Output



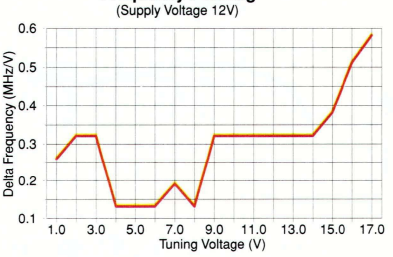
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-38.86	-37.29	-48.67
2.00	-39.43	-38.13	-47.66
3.00	-36.80	-38.13	-46.99
4.00	-36.14	-37.93	-46.81
5.00	-36.71	-37.62	-46.84
6.00	-38.19	-37.16	-47.09
7.00	-40.63	-36.75	-47.32
8.00	-43.55	-36.62	-47.30
9.00	-46.25	-36.79	-46.95
10.00	-48.45	-36.87	-45.68
11.00	-50.31	-37.04	-44.06
12.00	-49.36	-37.30	-42.30
13.00	-46.71	-37.33	-40.55
14.00	-45.09	-37.28	-38.87
15.00	-43.85	-36.89	-37.30
16.00	-41.85	-36.21	-35.76
17.00	-39.21	-35.61	-34.70

V TUNE	FREQ. PUSHING (MHz/V)
1.00	0.26
2.00	0.32
3.00	0.32
4.00	0.13
5.00	0.13
6.00	0.13
7.00	0.19
8.00	0.13
9.00	0.32
10.00	0.32
11.00	0.32
12.00	0.32
13.00	0.32
14.00	0.32
15.00	0.38
16.00	0.51
17.00	0.58

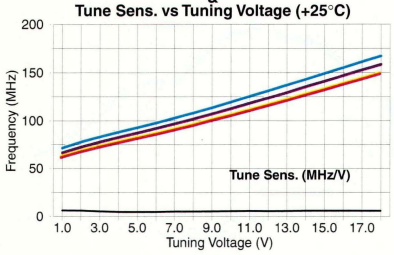
Frequency Pushing
(Supply Voltage 12V)



ROS-150

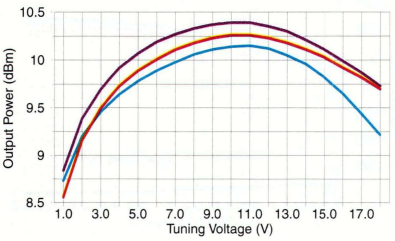
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

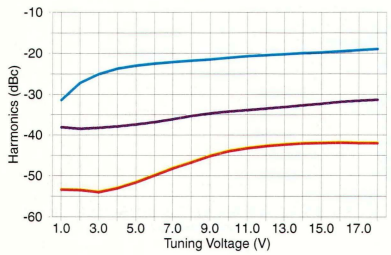


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	6.27	69.95	67.84	64.32	8.74	8.85	8.57
2.00	6.08	76.29	73.92	70.21	9.21	9.40	9.17
3.00	5.25	81.60	79.17	75.20	9.47	9.71	9.51
4.00	4.67	86.46	83.84	79.62	9.65	9.93	9.74
5.00	4.67	91.20	88.51	83.97	9.79	10.08	9.90
6.00	4.67	96.06	93.18	88.32	9.90	10.20	10.02
7.00	4.86	101.18	98.05	92.86	9.99	10.28	10.12
8.00	5.12	106.50	103.17	97.66	10.07	10.34	10.19
9.00	5.31	112.13	108.48	102.66	10.12	10.38	10.24
10.00	5.44	117.89	113.92	107.78	10.15	10.40	10.27
11.00	5.63	123.71	119.55	113.02	10.16	10.40	10.27
12.00	5.57	129.54	125.12	118.34	10.13	10.36	10.24
13.00	5.63	135.49	130.75	123.65	10.06	10.31	10.19
14.00	5.76	141.44	136.51	129.09	9.97	10.22	10.12
15.00	5.76	147.46	142.27	134.66	9.83	10.12	10.04
16.00	5.89	153.66	148.16	140.22	9.66	10.00	9.93
17.00	5.89	159.81	154.05	145.79	9.45	9.88	9.83
18.00	5.76	165.70	159.81	151.36	9.23	9.74	9.71

Power Output



Harmonics

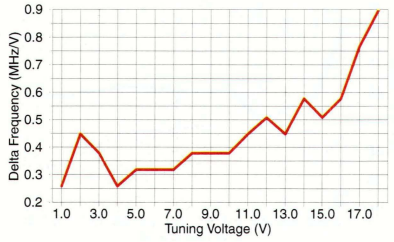


V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-31.19	-37.91	-53.23
2.00	-26.97	-38.30	-53.32
3.00	-24.80	-38.04	-53.83
4.00	-23.48	-37.71	-52.90
5.00	-22.75	-37.21	-51.42
6.00	-22.30	-36.62	-49.78
7.00	-21.90	-35.92	-48.03
8.00	-21.57	-35.15	-46.59
9.00	-21.29	-34.48	-44.97
10.00	-20.85	-34.03	-43.84
11.00	-20.46	-33.69	-43.10
12.00	-20.23	-33.33	-42.58
13.00	-19.98	-32.92	-42.18
14.00	-19.67	-32.49	-41.94
15.00	-19.55	-32.11	-41.82
16.00	-19.28	-31.64	-41.74
17.00	-18.99	-31.35	-41.81
18.00	-18.68	-31.15	-41.79

FREQ. PUSHING (MHz/V)
0.26
0.45
0.38
0.26
0.32
0.32
0.32
0.38
0.38
0.38
0.45
0.51
0.45
0.58
0.51
0.58
0.77
0.90

Frequency Pushing

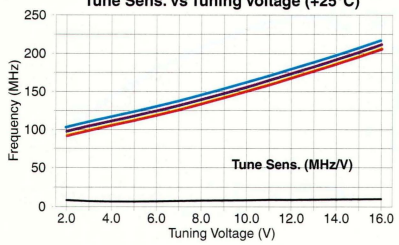
(Supply Voltage 12V)



ROS-200

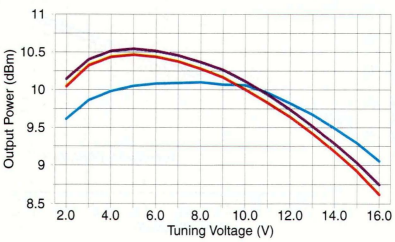
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

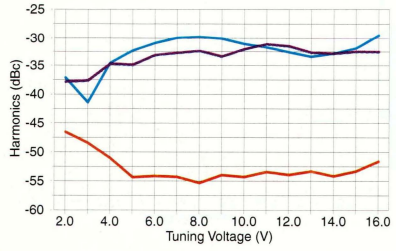


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
2.00	8.32	99.33	98.18	97.79	9.62	10.15	10.05
3.00	6.98	106.30	105.15	104.77	9.87	10.41	10.33
4.00	6.53	112.96	111.68	111.36	9.99	10.52	10.44
5.00	6.66	119.55	118.34	117.89	10.06	10.55	10.47
6.00	6.78	126.46	125.12	124.74	10.09	10.52	10.44
7.00	7.23	133.76	132.35	131.97	10.10	10.46	10.38
8.00	7.81	141.50	140.16	139.65	10.11	10.37	10.28
9.00	8.06	149.70	148.22	147.84	10.08	10.27	10.17
10.00	8.38	158.08	156.61	156.22	10.07	10.12	10.01
11.00	8.77	166.66	165.38	164.86	9.97	9.94	9.83
12.00	8.77	175.42	174.14	173.70	9.83	9.74	9.64
13.00	9.02	184.45	183.17	182.78	9.68	9.52	9.42
14.00	9.34	193.73	192.51	192.13	9.50	9.29	9.18
15.00	9.73	203.39	202.24	201.86	9.30	9.03	8.92
16.00	9.98	213.38	212.22	211.84	9.06	8.75	8.62

Power Output



Harmonics

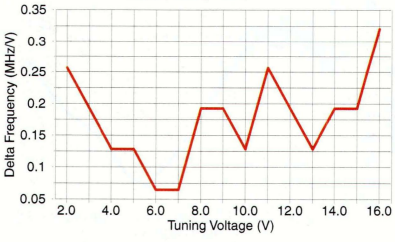


V TUNE	HARMONICS (dBc) F2	F3	F4
2.00	-37.06	-37.83	-46.61
3.00	-41.37	-37.64	-48.51
4.00	-34.49	-34.69	-51.10
5.00	-32.28	-34.91	-54.39
6.00	-30.82	-33.13	-54.18
7.00	-29.89	-32.73	-54.34
8.00	-29.72	-32.36	-55.39
9.00	-30.02	-33.39	-54.01
10.00	-30.98	-32.03	-54.35
11.00	-31.63	-31.07	-53.48
12.00	-32.53	-31.46	-53.99
13.00	-33.36	-32.68	-53.40
14.00	-32.80	-32.87	-54.21
15.00	-31.78	-32.51	-53.40
16.00	-29.40	-32.52	-51.67

FREQ. PUSHING (MHz/V)
0.26
0.19
0.13
0.13
0.06
0.06
0.19
0.19
0.13
0.26
0.19
0.13
0.19
0.19
0.32

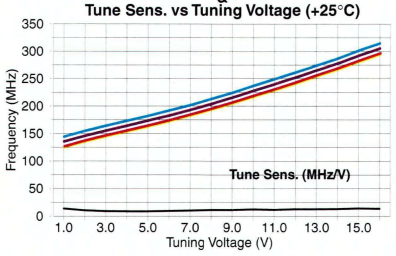
Frequency Pushing

(Supply Voltage 12V)

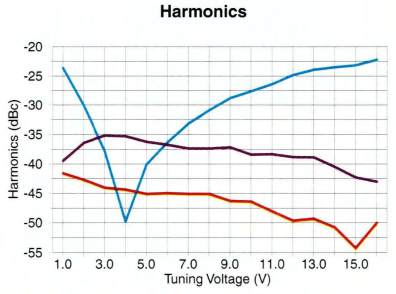


ROS-300

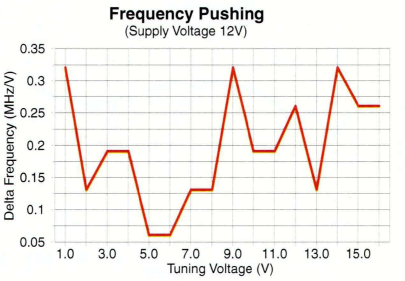
Linear Tuning - spec pg. 58



V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	14.02	136.70	134.78	133.76	7.66	8.60	8.27
2.00	10.50	147.20	145.28	144.26	8.20	9.39	9.21
3.00	9.34	156.48	154.62	153.54	8.39	9.73	9.63
4.00	8.90	165.44	163.52	162.43	8.53	9.96	9.86
5.00	9.02	174.53	172.54	171.46	8.63	10.11	9.96
6.00	9.73	184.32	182.27	180.93	8.59	10.14	10.04
7.00	10.11	194.43	192.38	191.10	8.59	10.22	10.10
8.00	11.07	205.70	203.46	201.98	8.61	10.25	10.13
9.00	11.52	217.02	214.98	213.57	8.60	10.19	10.05
10.00	12.22	229.63	227.20	225.66	8.40	10.01	10.00
11.00	11.90	241.41	239.10	237.57	8.23	9.92	9.90
12.00	12.54	253.95	251.65	250.11	7.97	9.72	9.66
13.00	12.67	266.50	264.32	262.59	7.73	9.46	9.35
14.00	12.99	279.55	277.31	275.84	7.16	8.95	8.87
15.00	14.14	294.08	291.46	289.73	6.76	8.46	8.50
16.00	13.44	307.20	304.90	303.30	6.39	8.05	8.15

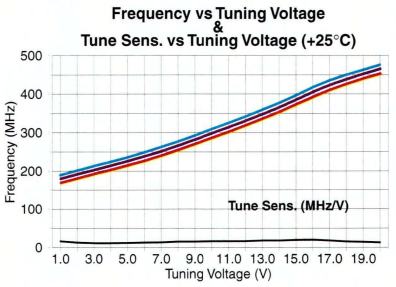


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-23.71	-39.50	-41.63	0.32
2.00	-30.16	-36.45	-42.78	0.13
3.00	-37.90	-35.20	-44.11	0.19
4.00	-49.94	-35.35	-44.42	0.19
5.00	-40.15	-36.29	-45.18	0.06
6.00	-36.40	-36.79	-45.03	0.06
7.00	-33.22	-37.44	-45.20	0.13
8.00	-31.00	-37.43	-45.19	0.13
9.00	-28.88	-37.23	-46.36	0.32
10.00	-27.72	-38.45	-46.50	0.19
11.00	-26.48	-38.39	-48.14	0.19
12.00	-24.91	-38.90	-49.73	0.26
13.00	-24.03	-38.94	-49.38	0.13
14.00	-23.58	-40.56	-50.86	0.32
15.00	-23.24	-42.37	-54.35	0.26
16.00	-22.31	-43.10	-50.14	0.26

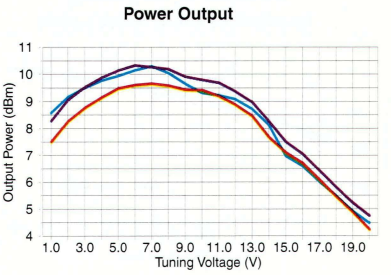


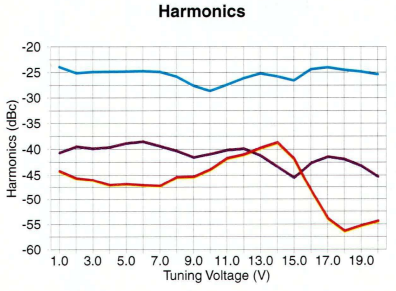
ROS-400

Linear Tuning - spec pg. 58

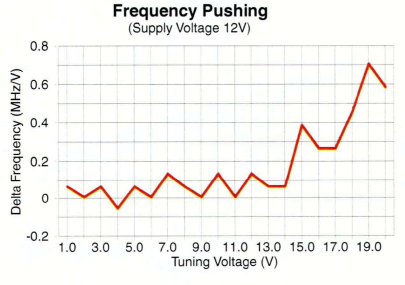


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	16.38	179.97	177.60	176.26	8.55	8.24	7.47
2.00	12.42	192.32	190.02	188.54	9.14	9.02	8.23
3.00	11.26	203.71	201.28	199.74	9.47	9.49	8.73
4.00	11.07	214.98	212.35	210.75	9.74	9.84	9.12
5.00	11.65	226.50	224.00	222.21	9.91	10.11	9.45
6.00	12.67	239.55	236.67	234.30	10.12	10.30	9.57
7.00	13.25	253.12	249.92	247.94	10.27	10.23	9.62
8.00	15.10	268.03	265.02	262.46	10.02	10.16	9.55
9.00	15.04	283.52	280.06	277.89	9.63	9.88	9.40
10.00	16.45	299.65	296.51	294.08	9.29	9.76	9.38
11.00	16.19	316.22	312.70	309.89	9.20	9.65	9.17
12.00	16.32	332.54	329.02	326.53	9.06	9.33	8.85
13.00	17.54	350.40	346.56	343.74	8.70	8.94	8.43
14.00	17.54	367.74	364.10	361.47	8.10	8.23	7.64
15.00	19.52	387.07	383.62	380.93	6.95	7.46	7.07
16.00	19.90	407.87	403.52	400.19	6.57	7.02	6.67
17.00	17.86	426.24	421.38	417.79	5.99	6.40	6.05
18.00	15.23	440.83	436.61	433.79	5.44	5.76	5.42
19.00	14.08	453.63	450.69	448.06	4.90	5.19	4.85
20.00	12.42	466.43	463.10	460.03	4.45	4.71	4.21



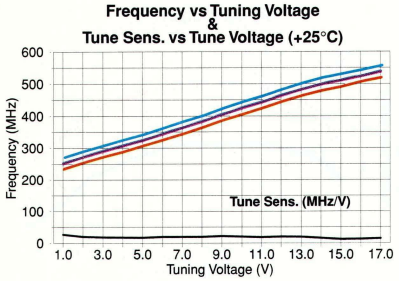


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-24.09	-40.80	-44.37	0.06
2.00	-25.26	-39.65	-45.79	0.00
3.00	-25.02	-40.01	-46.16	0.06
4.00	-25.00	-39.77	-47.19	-0.06
5.00	-24.96	-39.04	-47.00	0.06
6.00	-24.91	-38.71	-47.24	0.00
7.00	-25.03	-39.60	-47.39	0.13
8.00	-25.95	-40.49	-45.57	0.06
9.00	-27.74	-41.74	-45.49	0.00
10.00	-28.76	-41.06	-44.06	0.13
11.00	-27.57	-40.30	-41.89	0.00
12.00	-26.30	-40.04	-41.16	0.13
13.00	-25.35	-41.39	-39.93	0.06
14.00	-25.91	-43.54	-38.90	0.06
15.00	-26.71	-45.68	-42.00	0.38
16.00	-24.56	-42.85	-48.34	0.26
17.00	-24.18	-41.65	-54.06	0.26
18.00	-24.68	-42.06	-56.52	0.45
19.00	-25.00	-43.40	-55.40	0.70
20.00	-25.51	-45.46	-54.55	0.58

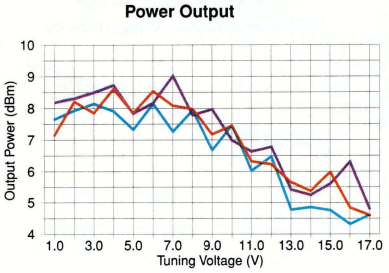


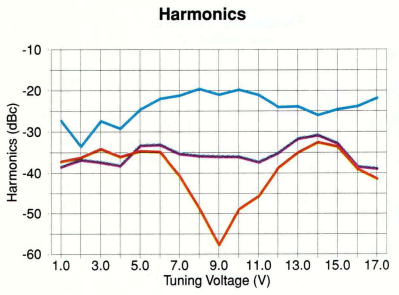
ROS-535

Linear Tuning - spec pg. 58

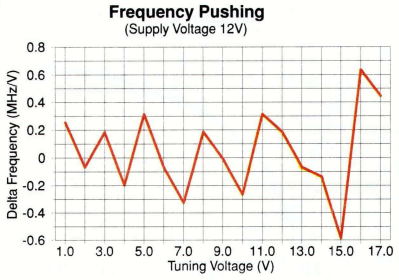


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	26.56	256.90	253.31	250.30	7.65	8.20	7.17
2.00	19.90	276.80	273.22	269.89	7.93	8.32	8.23
3.00	17.98	294.53	291.20	288.06	8.14	8.51	7.87
4.00	17.41	312.58	308.61	304.45	7.91	8.73	8.63
5.00	17.15	328.96	325.76	322.94	7.32	7.85	7.87
6.00	19.71	349.18	345.47	341.76	8.14	8.18	8.56
7.00	19.33	369.22	364.80	360.00	7.26	9.03	8.10
8.00	19.07	387.26	383.87	380.54	7.93	7.80	8.00
9.00	21.95	409.98	405.82	402.11	6.67	7.98	7.20
10.00	20.42	430.21	426.24	421.25	7.47	7.00	7.47
11.00	17.98	448.26	444.22	440.51	6.02	6.64	6.34
12.00	20.35	469.06	464.58	460.48	6.47	6.79	6.24
13.00	19.14	488.26	483.71	478.85	4.77	5.43	5.67
14.00	16.13	504.38	499.84	494.46	4.85	5.26	5.39
15.00	12.03	516.48	511.87	506.82	4.75	5.62	6.00
16.00	12.67	528.77	524.54	522.24	4.31	6.31	4.86
17.00	14.53	542.85	539.07	534.85	4.62	4.79	4.62



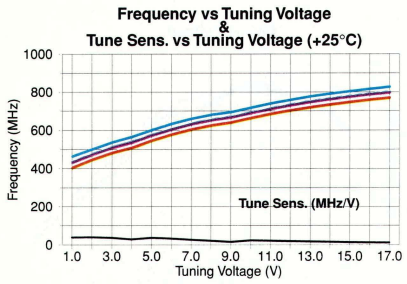


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-27.38	-38.33	-37.02	0.26
2.00	-33.58	-36.70	-36.04	-0.06
3.00	-27.41	-37.27	-33.99	0.19
4.00	-29.24	-38.10	-35.89	-0.19
5.00	-24.60	-33.24	-34.54	0.32
6.00	-22.01	-33.06	-34.68	-0.06
7.00	-21.20	-35.28	-40.46	-0.32
8.00	-19.59	-35.82	-48.52	0.19
9.00	-21.06	-35.91	-57.57	0.00
10.00	-19.80	-35.96	-48.72	-0.26
11.00	-21.11	-37.25	-45.48	0.32
12.00	-24.06	-35.08	-38.59	0.19
13.00	-23.89	-31.64	-34.89	-0.06
14.00	-25.99	-30.78	-32.40	-0.13
15.00	-24.64	-32.79	-33.44	-0.58
16.00	-23.87	-38.34	-38.77	0.64
17.00	-21.87	-38.79	-41.19	0.45

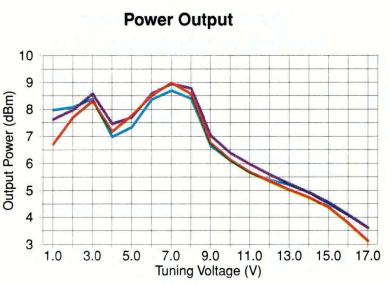


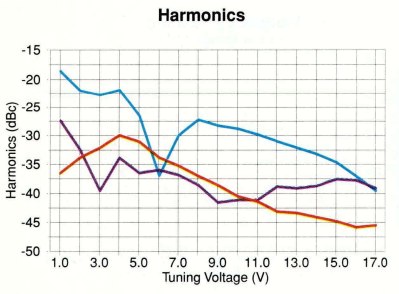
ROS-765

Linear Tuning - spec pg. 58

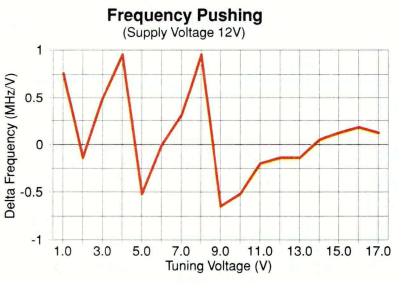


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	38.08	444.48	436.03	429.50	7.97	7.65	6.74
2.00	39.81	481.98	475.84	471.10	8.08	7.99	7.72
3.00	35.90	517.76	511.74	506.24	8.39	8.60	8.34
4.00	28.03	545.98	539.78	533.82	6.98	7.48	7.20
5.00	36.29	582.59	576.06	571.20	7.34	7.72	7.80
6.00	32.26	614.91	608.32	603.14	8.36	8.61	8.54
7.00	26.11	640.90	634.43	629.18	8.70	8.98	9.02
8.00	20.99	661.38	655.42	649.47	8.39	8.80	8.60
9.00	14.85	675.58	670.27	666.05	6.65	7.05	6.78
10.00	23.30	699.39	693.57	689.02	6.11	6.40	6.15
11.00	21.18	721.09	714.75	709.82	5.67	5.99	5.71
12.00	18.88	740.03	733.63	728.26	5.40	5.61	5.37
13.00	16.64	757.44	750.27	744.96	5.22	5.27	5.06
14.00	15.17	772.80	765.44	759.87	4.94	4.95	4.77
15.00	13.25	786.24	778.69	773.12	4.49	4.58	4.40
16.00	11.97	798.34	790.66	784.45	4.07	4.11	3.81
17.00	10.30	808.83	800.96	794.69	3.63	3.62	3.15





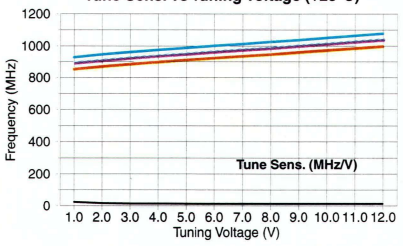
V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-18.55	-27.29	-36.35	0.77
2.00	-21.89	-32.31	-33.63	-0.13
3.00	-22.69	-39.40	-31.97	0.51
4.00	-21.77	-33.74	-29.75	0.96
5.00	-26.48	-36.37	-30.93	-0.51
6.00	-36.88	-35.81	-33.65	0.00
7.00	-29.91	-36.72	-35.05	0.32
8.00	-27.19	-38.42	-36.84	0.96
9.00	-28.24	-41.45	-38.44	-0.64
10.00	-28.77	-41.03	-40.34	-0.51
11.00	-29.79	-41.02	-41.26	-0.19
12.00	-30.94	-38.70	-42.96	-0.13
13.00	-32.06	-39.00	-43.19	-0.13
14.00	-33.14	-38.59	-43.91	0.06
15.00	-34.60	-37.44	-44.61	0.13
16.00	-36.99	-37.64	-45.65	0.19
17.00	-39.48	-39.00	-45.31	0.13



ROS-1000V

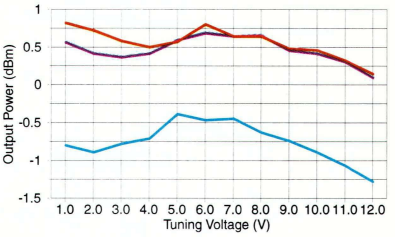
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

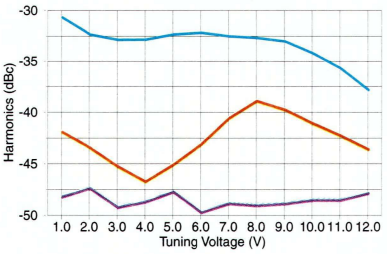


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	24.28	899.10	893.15	887.76	-0.80	0.57	0.83
2.0	17.50	916.42	910.66	905.22	-0.89	0.42	0.73
3.0	14.96	931.38	925.62	920.03	-0.78	0.37	0.59
4.0	13.68	945.08	939.30	933.53	-0.71	0.42	0.51
5.0	12.91	958.03	952.21	946.29	-0.39	0.60	0.58
6.0	12.44	970.51	964.66	958.63	-0.47	0.69	0.81
7.0	12.25	982.75	976.91	970.81	-0.45	0.65	0.65
8.0	12.24	994.95	989.15	982.99	-0.63	0.66	0.65
9.0	12.43	1007.34	1001.58	995.33	-0.74	0.46	0.49
10.0	12.72	1020.15	1014.30	1007.86	-0.89	0.42	0.47
11.0	12.92	1033.49	1027.22	1020.46	-1.07	0.31	0.33
12.0	12.81	1047.09	1040.03	1032.75	-1.28	0.10	0.15

Power Output



Harmonics

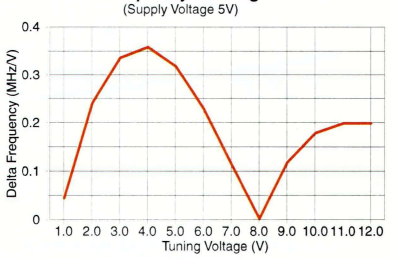


V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-30.66	-48.16	-41.83
2.0	-32.33	-47.33	-43.33
3.0	-32.84	-49.17	-45.17
4.0	-32.83	-48.66	-46.66
5.0	-32.33	-47.67	-45.00
6.0	-32.17	-49.67	-43.00
7.0	-32.50	-48.83	-40.50
8.0	-32.66	-49.00	-38.83
9.0	-33.00	-48.84	-39.67
10.0	-34.17	-48.50	-41.00
11.0	-35.67	-48.50	-42.17
12.0	-37.83	-47.84	-43.50

FREQ. PUSHING (MHz/V)
0.05
0.24
0.34
0.36
0.32
0.23
0.12
0.00
0.12
0.18
0.20
0.20

Frequency Pushing

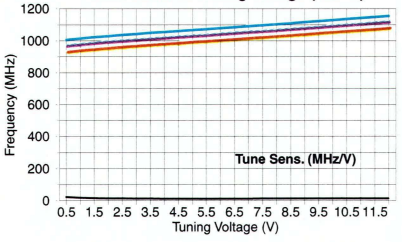
(Supply Voltage 5V)



ROS-1100V

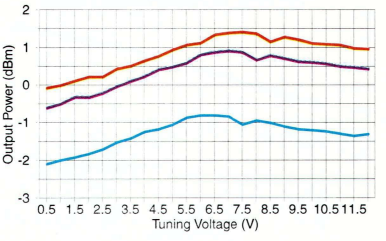
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

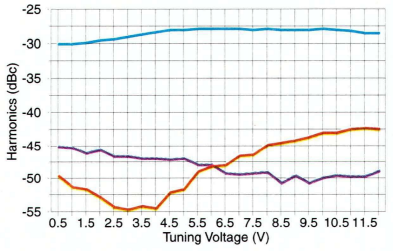


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.5	22.86	976.23	970.63	965.38	-2.10	-0.60	-0.06
1.0	18.13	985.00	979.69	974.64	-2.00	-0.49	0.01
1.5	15.82	992.77	987.60	982.61	-1.92	-0.31	0.13
2.0	14.42	999.89	994.81	989.84	-1.83	-0.32	0.24
2.5	13.47	1006.59	1001.55	996.55	-1.71	-0.21	0.24
3.0	12.88	1013.02	1007.99	1002.96	-1.53	-0.03	0.45
3.5	12.44	1019.25	1014.21	1009.13	-1.42	0.11	0.53
4.0	12.14	1025.35	1020.28	1015.16	-1.25	0.24	0.67
4.5	12.02	1031.37	1026.29	1021.10	-1.18	0.42	0.79
5.0	11.90	1037.36	1032.24	1026.99	-1.06	0.50	0.96
5.5	11.90	1043.34	1038.19	1032.87	-0.87	0.60	1.09
6.0	11.93	1049.35	1044.16	1038.76	-0.81	0.82	1.14
6.5	12.04	1055.42	1050.18	1044.72	-0.81	0.89	1.36
7.0	12.18	1061.56	1056.27	1050.73	-0.84	0.92	1.41
7.5	12.32	1067.79	1062.43	1056.82	-1.06	0.89	1.43
8.0	12.54	1074.11	1068.70	1063.00	-0.95	0.68	1.39
8.5	12.74	1080.54	1075.07	1069.31	-1.01	0.80	1.17
9.0	12.87	1087.02	1081.50	1075.64	-1.11	0.72	1.30
9.5	13.02	1093.57	1088.01	1082.07	-1.18	0.64	1.23
10.0	13.05	1100.16	1094.54	1088.52	-1.21	0.62	1.13
10.5	13.05	1106.73	1101.06	1094.97	-1.24	0.58	1.11
11.0	12.90	1113.19	1107.51	1101.34	-1.30	0.51	1.09
11.5	12.62	1119.53	1113.82	1107.60	-1.36	0.48	1.00
12.0	12.29	1125.68	1119.97	1113.67	-1.31	0.44	0.98

Power Output



Harmonics

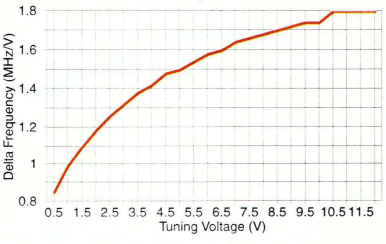


V TUNE	HARMONICS (dBc) F2	F3	F4
0.5	-30.00	-45.00	-49.50
1.0	-30.00	-45.17	-51.17
1.5	-29.84	-46.00	-51.50
2.0	-29.50	-45.50	-52.67
2.5	-29.33	-46.50	-54.16
3.0	-29.00	-46.50	-54.50
3.5	-28.66	-46.83	-54.00
4.0	-28.33	-46.83	-54.33
4.5	-28.00	-47.00	-52.00
5.0	-28.00	-46.84	-51.50
5.5	-27.84	-47.84	-48.84
6.0	-27.84	-47.84	-48.00
6.5	-27.83	-49.17	-47.83
7.0	-27.83	-49.33	-46.33
7.5	-28.00	-49.17	-46.17
8.0	-27.84	-49.00	-44.67
8.5	-28.00	-50.67	-44.34
9.0	-28.00	-49.50	-44.00
9.5	-28.00	-50.67	-43.50
10.0	-27.83	-49.83	-42.83
10.5	-28.00	-49.50	-42.83
11.0	-28.16	-49.66	-42.33
11.5	-28.50	-49.66	-42.16
12.0	-28.50	-48.84	-42.33

FREQ. PUSHING (MHz/V)
0.85
0.99
1.10
1.19
1.26
1.32
1.38
1.42
1.48
1.50
1.54
1.58
1.60
1.64
1.66
1.68
1.70
1.72
1.74
1.74
1.80
1.80
1.80
1.80

Frequency Pushing

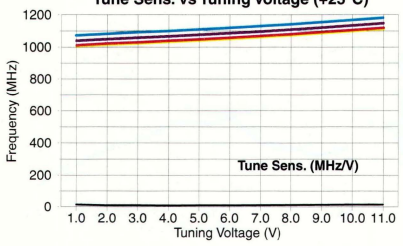
(Supply Voltage 5V)



ROS-1121V

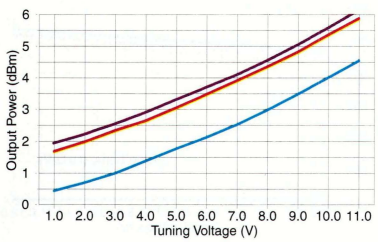
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

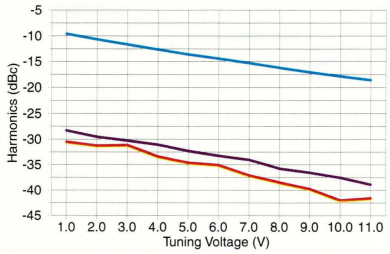


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	13.36	1040.92	1035.70	1033.92	0.43	1.78	1.67
2.0	10.02	1050.77	1045.71	1043.96	0.69	2.06	1.98
3.0	9.03	1059.79	1054.75	1052.96	0.99	2.37	2.32
4.0	8.83	1068.66	1063.58	1061.72	1.37	2.73	2.63
5.0	9.03	1077.78	1072.61	1070.68	1.76	3.14	3.04
6.0	9.63	1087.55	1082.23	1080.20	2.12	3.53	3.47
7.0	10.50	1098.23	1092.74	1090.60	2.51	3.93	3.90
8.0	11.59	1110.01	1104.32	1102.06	2.97	4.39	4.35
9.0	12.65	1122.85	1116.97	1114.59	3.48	4.88	4.81
10.0	13.36	1136.40	1130.34	1127.89	4.00	5.41	5.35
11.0	13.51	1150.07	1143.85	1141.35	4.54	5.97	5.86

Power Output



Harmonics

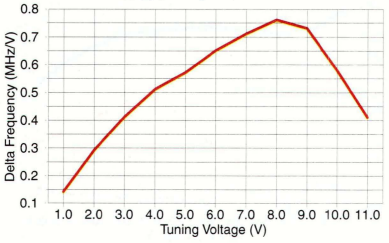


V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-9.69	-28.43	-30.63
2.0	-10.76	-29.67	-31.40
3.0	-11.77	-30.42	-31.26
4.0	-12.77	-31.20	-33.52
5.0	-13.69	-32.42	-34.73
6.0	-14.53	-33.37	-35.16
7.0	-15.38	-34.16	-37.21
8.0	-16.33	-35.88	-38.59
9.0	-17.21	-36.65	-39.86
10.0	-18.00	-37.65	-42.11
11.0	-18.73	-39.01	-41.72

FREQ. PUSHING (MHz/V)
0.14
0.29
0.41
0.51
0.57
0.65
0.71
0.76
0.73
0.58
0.41

Frequency Pushing

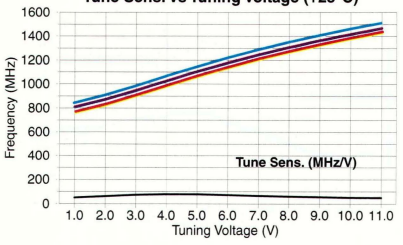
(Supply Voltage 5V)



ROS-1410

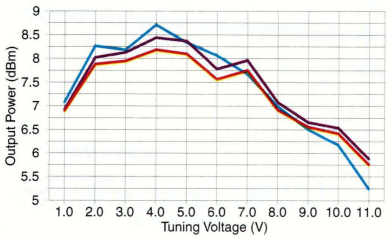
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

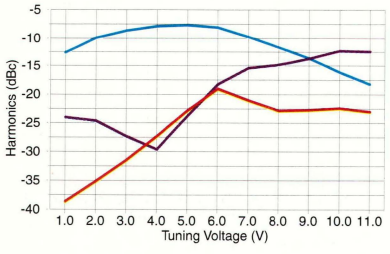


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	50.40	807.72	801.40	796.23	7.06	6.91	6.88
2.0	63.50	873.09	864.86	860.66	8.25	8.00	7.86
3.0	74.30	949.34	939.17	936.08	8.17	8.11	7.93
4.0	79.80	1030.94	1018.98	1017.08	8.69	8.42	8.17
5.0	78.90	1111.03	1097.86	1097.10	8.32	8.35	8.08
6.0	73.80	1185.85	1171.66	1172.04	8.05	7.76	7.54
7.0	66.90	1253.22	1238.55	1240.14	7.66	7.95	7.73
8.0	61.20	1315.49	1299.71	1302.25	6.98	7.06	6.90
9.0	57.00	1373.25	1356.73	1360.05	6.49	6.64	6.54
10.0	52.80	1427.15	1409.55	1413.71	6.16	6.52	6.40
11.0	49.60	1477.46	1459.17	1464.05	5.23	5.86	5.74

Power Output



Harmonics

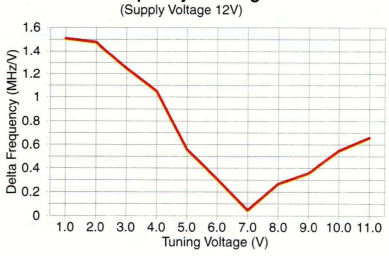


V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-12.80	-24.20	-38.80
2.0	-10.10	-24.80	-35.30
3.0	-8.80	-27.50	-31.70
4.0	-8.00	-29.80	-27.50
5.0	-7.80	-24.00	-23.00
6.0	-8.20	-18.50	-19.20
7.0	-9.90	-15.60	-21.20
8.0	-11.80	-15.00	-23.00
9.0	-13.80	-13.90	-22.90
10.0	-16.30	-12.50	-22.60
11.0	-18.40	-12.60	-23.20

FREQ. PUSHING (MHz/V)
1.50
1.47
1.24
1.04
0.55
0.30
0.04
0.26
0.35
0.54
0.65

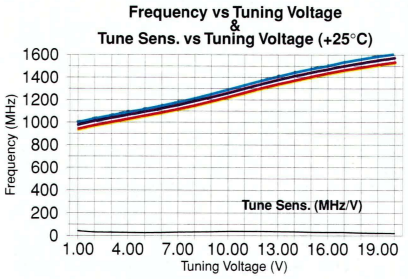
Frequency Pushing

(Supply Voltage 12V)

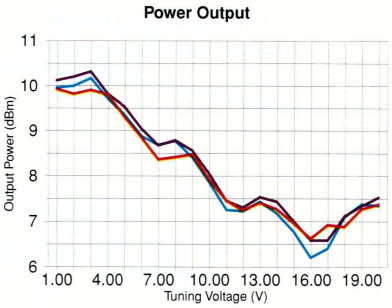


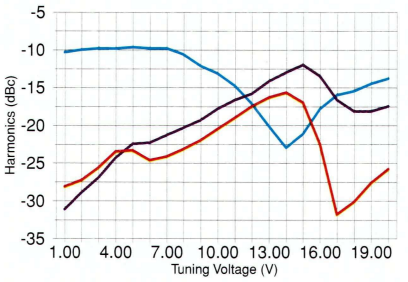
ROS-1500

Linear Tuning - spec pg. 58



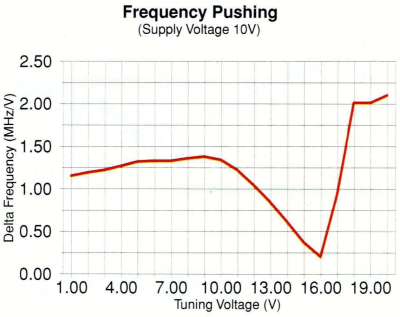
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	42.02	990.22	982.48	972.73	9.95	10.11	9.92
2.00	31.87	1021.64	1014.36	1005.33	9.99	10.19	9.81
3.00	29.16	1050.64	1043.52	1034.68	10.16	10.31	9.90
4.00	28.12	1078.59	1071.64	1063.04	9.71	9.82	9.80
5.00	27.57	1106.13	1099.21	1090.87	9.35	9.53	9.30
6.00	28.79	1134.98	1128.00	1119.69	8.88	9.04	8.85
7.00	30.94	1166.04	1158.94	1150.55	8.68	8.67	8.36
8.00	33.02	1199.24	1191.96	1183.49	8.77	8.78	8.41
9.00	35.74	1235.35	1227.70	1219.01	8.41	8.56	8.47
10.00	38.43	1273.94	1266.14	1257.23	7.86	8.05	7.92
11.00	39.35	1313.61	1305.49	1296.40	7.25	7.45	7.46
12.00	39.09	1353.06	1344.58	1335.22	7.22	7.30	7.24
13.00	36.92	1390.14	1381.50	1372.08	7.43	7.53	7.41
14.00	33.72	1424.01	1415.22	1405.79	7.17	7.43	7.26
15.00	30.83	1454.49	1446.05	1437.24	6.77	7.00	6.96
16.00	30.53	1483.66	1476.58	1468.08	6.20	6.58	6.62
17.00	29.56	1515.16	1506.14	1496.29	6.40	6.58	6.92
18.00	25.93	1542.21	1532.07	1521.52	7.09	7.11	6.88
19.00	23.12	1565.45	1555.19	1544.39	7.37	7.33	7.26
20.00	21.03	1586.27	1576.22	1565.46	7.34	7.52	7.37





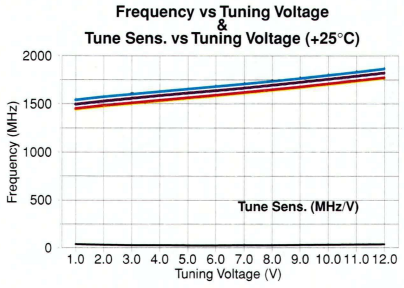
V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-10.33	-31.16	-28.16
2.00	-10.00	-29.00	-27.33
3.00	-9.83	-27.00	-25.66
4.00	-9.84	-24.34	-23.50
5.00	-9.66	-22.50	-23.33
6.00	-9.83	-22.33	-24.66
7.00	-9.83	-21.33	-24.17
8.00	-10.66	-20.33	-23.16
9.00	-12.16	-19.33	-22.00
10.00	-13.16	-17.83	-20.50
11.00	-14.83	-16.67	-19.00
12.00	-17.17	-15.84	-17.50
13.00	-20.16	-14.16	-16.33
14.00	-23.00	-13.00	-15.67
15.00	-21.17	-12.00	-17.00
16.00	-17.84	-13.50	-22.50
17.00	-16.00	-16.67	-31.83
18.00	-15.50	-18.17	-30.17
19.00	-14.50	-18.17	-27.67
20.00	-13.84	-17.50	-25.84

FREQ. PUSHING (MHz/V)
1.15
1.19
1.22
1.27
1.32
1.33
1.33
1.36
1.38
1.34
1.22
1.04
0.84
0.61
0.37
0.20
0.94
2.01
2.01
2.10

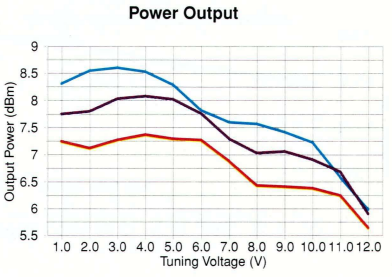


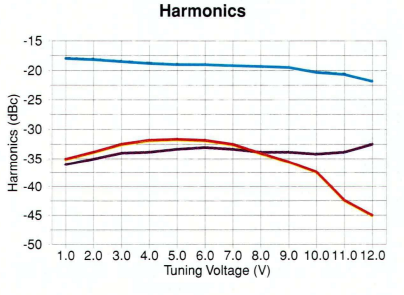
ROS-1720

Linear Tuning - spec pg. 58



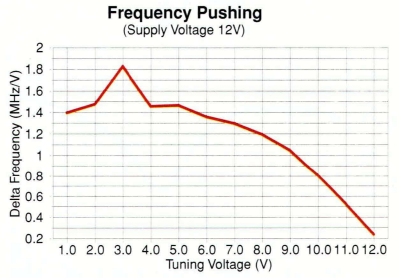
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	36.89	1508.43	1479.48	1469.47	8.30	7.74	7.23
2.0	32.60	1539.52	1512.07	1500.76	8.54	7.79	7.11
3.0	28.99	1567.28	1541.06	1529.70	8.60	8.02	7.26
4.0	27.45	1593.75	1568.51	1556.82	8.52	8.07	7.36
5.0	26.29	1619.89	1594.80	1583.20	8.28	8.01	7.28
6.0	26.66	1646.52	1621.46	1609.60	7.81	7.75	7.26
7.0	27.42	1673.97	1648.88	1636.90	7.59	7.28	6.87
8.0	28.74	1702.65	1677.62	1665.07	7.56	7.02	6.42
9.0	30.20	1733.14	1707.83	1694.74	7.41	7.05	6.40
10.0	31.98	1765.19	1739.81	1726.16	7.22	6.90	6.37
11.0	33.49	1798.68	1773.30	1759.13	6.57	6.67	6.23
12.0	34.79	1833.43	1808.09	1793.21	5.97	5.89	5.63





V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-18.17	-36.17	-35.17
2.0	-18.33	-35.17	-34.00
3.0	-18.67	-34.17	-32.67
4.0	-19.00	-34.00	-32.00
5.0	-19.16	-33.50	-31.83
6.0	-19.17	-33.17	-32.00
7.0	-19.33	-33.50	-32.66
8.0	-19.50	-34.00	-34.17
9.0	-19.66	-34.00	-35.66
10.0	-20.50	-34.33	-37.50
11.0	-20.83	-34.00	-42.50
12.0	-22.00	-32.67	-45.17

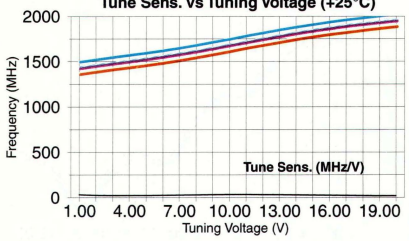
FREQ. PUSHING (MHz/V)
1.39
1.47
1.82
1.45
1.46
1.35
1.29
1.19
1.04
0.80
0.52
0.23



ROS-1900

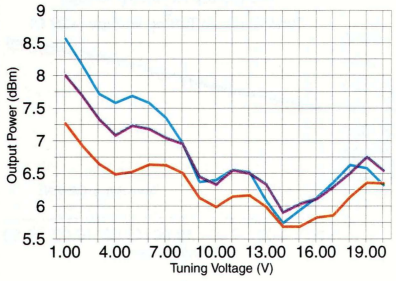
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

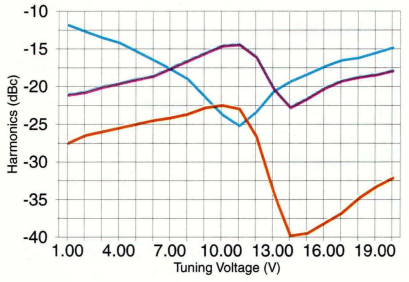


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	32.84	1441.05	1433.36	1427.06	8.57	8.01	7.28
2.00	25.83	1466.54	1459.20	1453.15	8.16	7.70	6.94
3.00	23.84	1490.34	1483.04	1477.10	7.72	7.34	6.66
4.00	23.60	1514.03	1506.64	1500.66	7.58	7.09	6.50
5.00	24.36	1538.50	1531.00	1524.93	7.69	7.24	6.54
6.00	25.98	1564.72	1556.97	1550.66	7.58	7.19	6.65
7.00	28.10	1593.12	1585.08	1578.61	7.35	7.05	6.64
8.00	30.78	1624.18	1615.85	1609.17	6.96	6.96	6.52
9.00	33.25	1657.76	1649.10	1642.25	6.37	6.46	6.14
10.00	34.89	1692.92	1683.99	1677.01	6.40	6.34	6.00
11.00	34.83	1727.99	1718.82	1711.85	6.56	6.56	6.16
12.00	33.94	1761.88	1752.76	1745.97	6.52	6.51	6.18
13.00	32.95	1794.61	1785.71	1778.80	6.08	6.34	6.00
14.00	30.80	1825.84	1816.51	1809.21	5.74	5.91	5.70
15.00	28.22	1854.43	1844.73	1837.19	5.94	6.04	5.70
16.00	25.99	1880.63	1870.72	1863.02	6.13	6.12	5.84
17.00	24.02	1904.72	1894.74	1886.92	6.36	6.30	5.87
18.00	22.41	1927.17	1917.15	1909.21	6.63	6.51	6.15
19.00	20.93	1948.17	1938.08	1930.09	6.58	6.76	6.37
20.00	19.74	1967.93	1957.82	1949.72	6.32	6.55	6.36

Power Output



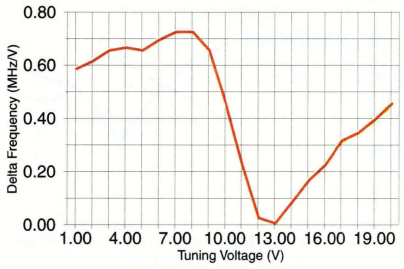
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-11.83	-21.00	-27.33
2.00	-12.67	-20.67	-26.33
3.00	-13.50	-20.00	-25.83
4.00	-14.17	-19.50	-25.33
5.00	-15.33	-19.00	-24.83
6.00	-16.50	-18.50	-24.33
7.00	-17.67	-17.50	-24.00
8.00	-19.00	-16.50	-23.50
9.00	-21.34	-15.50	-22.67
10.00	-23.67	-14.50	-22.33
11.00	-25.17	-14.33	-22.83
12.00	-23.33	-16.00	-26.50
13.00	-20.67	-20.17	-33.83
14.00	-19.33	-22.67	-39.67
15.00	-18.33	-21.50	-39.33
16.00	-17.33	-20.16	-38.00
17.00	-16.50	-19.16	-36.66
18.00	-16.17	-18.67	-34.67
19.00	-15.50	-18.33	-33.17
20.00	-14.83	-17.83	-32.00

V TUNE	FREQ. PUSHING (MHz/V)
1.00	0.59
2.00	0.62
3.00	0.66
4.00	0.67
5.00	0.66
6.00	0.70
7.00	0.73
8.00	0.73
9.00	0.66
10.00	0.46
11.00	0.23
12.00	0.03
13.00	0.01
14.00	0.09
15.00	0.17
16.00	0.23
17.00	0.32
18.00	0.35
19.00	0.40
20.00	0.46

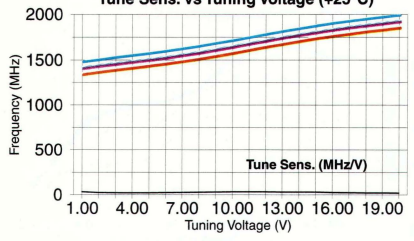
Frequency Pushing
(Supply Voltage 10V)



ROS-1900V

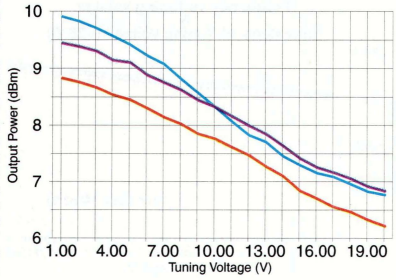
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

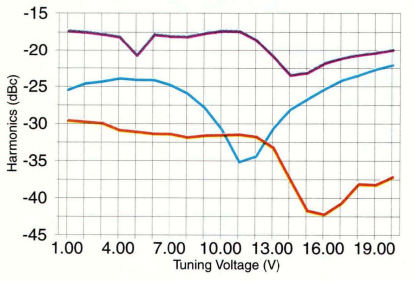


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	32.87	1427.73	1418.41	1410.51	9.91	9.46	8.85
2.00	24.89	1452.34	1443.30	1435.75	9.83	9.40	8.78
3.00	22.78	1475.12	1466.08	1458.57	9.71	9.32	8.69
4.00	22.40	1497.60	1488.48	1480.94	9.57	9.16	8.56
5.00	22.96	1520.63	1511.43	1503.81	9.42	9.12	8.47
6.00	24.04	1544.70	1535.48	1527.81	9.23	8.90	8.32
7.00	25.78	1570.62	1561.26	1553.44	9.08	8.77	8.16
8.00	28.28	1599.08	1589.54	1581.46	8.82	8.64	8.04
9.00	30.85	1629.94	1620.39	1612.19	8.58	8.46	7.87
10.00	32.68	1662.60	1653.07	1644.85	8.33	8.34	7.78
11.00	33.84	1696.66	1686.91	1678.65	8.07	8.17	7.63
12.00	33.83	1730.52	1720.74	1712.62	7.83	8.01	7.49
13.00	32.34	1762.70	1753.08	1745.22	7.71	7.86	7.29
14.00	30.92	1793.60	1784.00	1776.13	7.46	7.65	7.12
15.00	29.34	1823.02	1813.34	1805.24	7.30	7.43	6.86
16.00	26.99	1850.05	1840.33	1832.07	7.16	7.27	6.72
17.00	24.87	1875.05	1865.20	1856.77	7.09	7.18	6.57
18.00	23.22	1898.40	1888.42	1879.77	6.96	7.07	6.48
19.00	21.79	1920.22	1910.21	1901.38	6.83	6.93	6.34
20.00	20.34	1940.54	1930.55	1921.65	6.77	6.85	6.23

Power Output



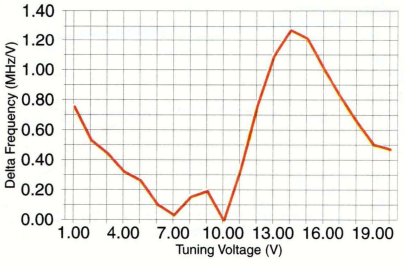
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-25.41	-17.20	-29.39
2.00	-24.53	-17.33	-29.56
3.00	-24.29	-17.62	-29.76
4.00	-23.89	-17.98	-30.68
5.00	-24.06	-20.63	-30.92
6.00	-24.08	-17.67	-31.17
7.00	-24.75	-17.91	-31.18
8.00	-25.89	-17.97	-31.65
9.00	-27.81	-17.51	-31.39
10.00	-30.72	-17.19	-31.34
11.00	-35.07	-17.25	-31.28
12.00	-34.31	-18.43	-31.60
13.00	-30.56	-20.80	-33.05
14.00	-28.06	-23.36	-37.30
15.00	-26.63	-23.01	-41.51
16.00	-25.31	-21.73	-42.02
17.00	-24.12	-21.03	-40.52
18.00	-23.42	-20.56	-37.92
19.00	-22.62	-20.24	-38.02
20.00	-22.03	-19.82	-36.97

V TUNE	FREQ. PUSHING (MHz/V)
1.00	0.76
2.00	0.54
3.00	0.45
4.00	0.33
5.00	0.27
6.00	0.11
7.00	0.04
8.00	0.16
9.00	0.20
10.00	0.00
11.00	0.34
12.00	0.77
13.00	1.10
14.00	1.28
15.00	1.22
16.00	1.01
17.00	0.83
18.00	0.66
19.00	0.51
20.00	0.48

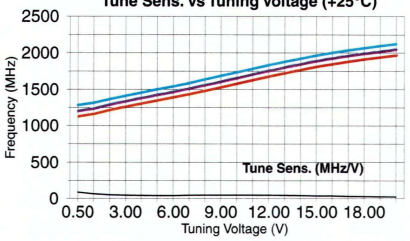
Frequency Pushing
(Supply Voltage 5V)



ROS-2000

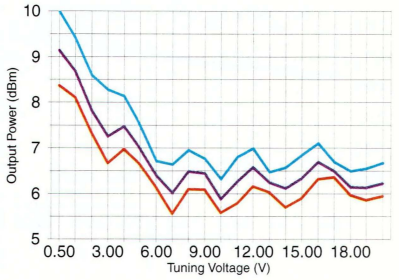
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

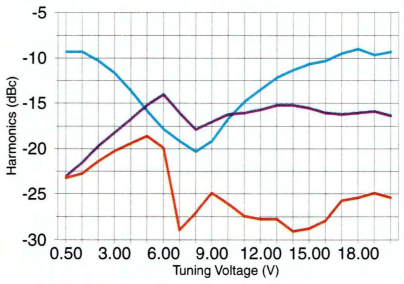


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	86.91	1223.89	1208.62	1199.19	9.99	9.15	8.38
1.00	65.56	1255.43	1241.40	1232.71	9.41	8.69	8.12
2.00	50.71	1307.05	1295.01	1286.96	8.59	7.83	7.34
3.00	45.84	1353.62	1341.75	1333.68	8.27	7.26	6.68
4.00	43.19	1397.48	1385.50	1377.26	8.13	7.48	6.98
5.00	42.31	1440.12	1427.94	1419.32	7.49	6.99	6.65
6.00	42.24	1482.29	1470.10	1461.39	6.71	6.41	6.15
7.00	47.10	1528.53	1515.45	1506.37	6.64	6.02	5.57
8.00	47.96	1578.79	1563.59	1553.16	6.95	6.49	6.11
9.00	48.11	1626.69	1611.48	1600.80	6.76	6.45	6.10
10.00	49.79	1675.83	1660.92	1649.99	6.32	5.89	5.59
11.00	49.75	1725.19	1710.73	1699.96	6.80	6.27	5.80
12.00	48.84	1773.74	1759.81	1749.15	6.99	6.58	6.17
13.00	46.57	1820.67	1807.12	1796.61	6.47	6.25	6.04
14.00	43.69	1865.20	1851.65	1841.05	6.57	6.12	5.71
15.00	40.39	1906.65	1892.92	1882.20	6.84	6.34	5.91
16.00	36.75	1944.69	1930.58	1919.58	7.10	6.70	6.33
17.00	33.64	1979.50	1965.03	1953.65	6.69	6.50	6.37
18.00	30.52	2011.22	1996.35	1984.66	6.49	6.15	5.98
19.00	27.85	2040.24	2024.86	2012.85	6.55	6.14	5.87
20.00	25.79	2066.97	2051.16	2038.74	6.67	6.23	5.96

Power Output

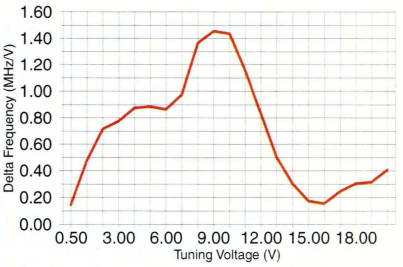


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-9.33	-23.00	-23.17	0.15
1.00	-9.34	-21.50	-22.67	0.48
2.00	-10.33	-19.67	-21.33	0.72
3.00	-11.67	-18.17	-20.17	0.78
4.00	-13.67	-16.67	-19.34	0.88
5.00	-15.84	-15.17	-18.50	0.89
6.00	-17.84	-14.00	-19.84	0.87
7.00	-19.16	-16.00	-28.83	0.98
8.00	-20.33	-17.83	-27.00	1.37
9.00	-19.16	-17.00	-24.83	1.46
10.00	-16.67	-16.17	-26.00	1.44
11.00	-14.84	-16.00	-27.34	1.16
12.00	-13.50	-15.67	-27.67	0.84
13.00	-12.17	-15.17	-27.67	0.51
14.00	-11.33	-15.17	-29.00	0.31
15.00	-10.67	-15.50	-28.67	0.18
16.00	-10.33	-16.00	-27.83	0.16
17.00	-9.50	-16.17	-25.67	0.25
18.00	-9.00	-16.00	-25.34	0.31
19.00	-9.67	-15.84	-24.84	0.32
20.00	-9.33	-16.33	-25.33	0.41

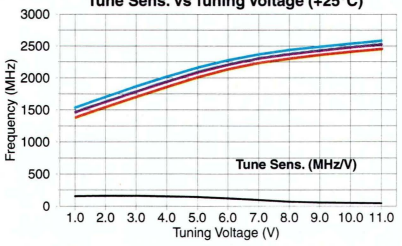
Frequency Pushing
(Supply Voltage 12V)



ROS-2500

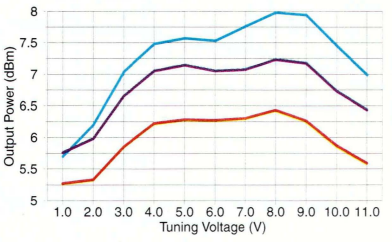
Linear Tuning - spec pg. 58

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

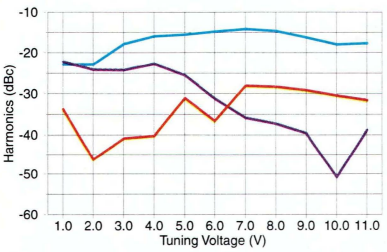


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	156.40	1501.52	1473.06	1445.18	5.70	5.77	5.28
2.0	161.35	1671.28	1634.41	1603.80	6.20	5.99	5.34
3.0	162.52	1835.76	1796.93	1766.70	7.04	6.66	5.86
4.0	152.45	1986.50	1949.39	1922.75	7.48	7.06	6.23
5.0	143.59	2126.51	2092.98	2068.65	7.57	7.15	6.29
6.0	123.11	2245.23	2216.09	2194.09	7.53	7.06	6.28
7.0	95.41	2338.10	2311.50	2290.61	7.76	7.08	6.31
8.0	68.87	2405.31	2380.37	2360.90	7.98	7.24	6.44
9.0	54.46	2455.83	2434.83	2417.91	7.94	7.18	6.27
10.0	50.25	2504.20	2485.08	2467.35	7.45	6.74	5.88
11.0	45.50	2551.88	2530.58	2511.16	6.99	6.44	5.60

Power Output

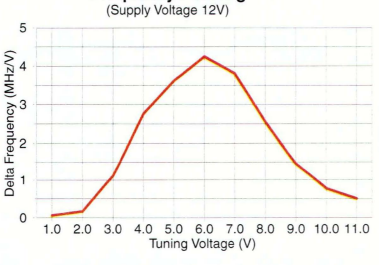


Harmonics



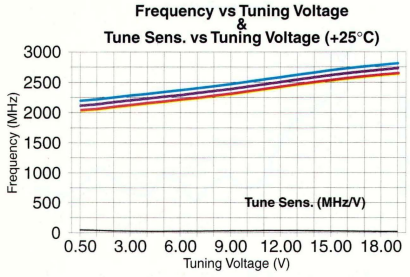
V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-22.77	-22.05	-33.59	0.08
2.0	-22.77	-24.00	-46.07	0.19
3.0	-17.81	-24.11	-40.65	1.14
4.0	-15.93	-22.59	-40.02	2.78
5.0	-15.51	-25.38	-30.92	3.63
6.0	-14.73	-31.08	-36.45	4.26
7.0	-14.11	-35.78	-27.91	3.83
8.0	-14.60	-37.16	-28.17	2.58
9.0	-16.19	-39.47	-29.03	1.47
10.0	-17.95	-50.70	-30.33	0.79
11.0	-17.67	-38.68	-31.47	0.52

Frequency Pushing
(Supply Voltage 12V)

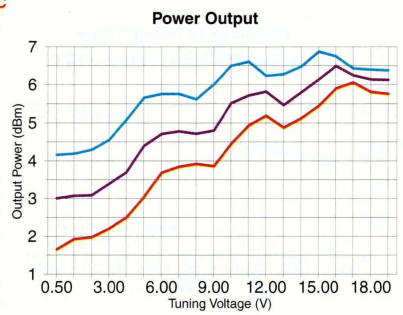


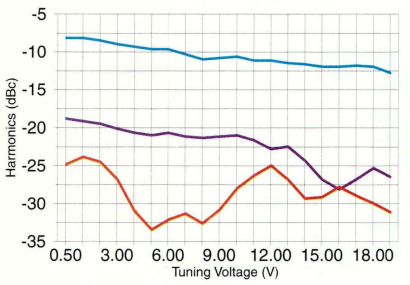
ROS-2650

Linear Tuning - spec pg. 58

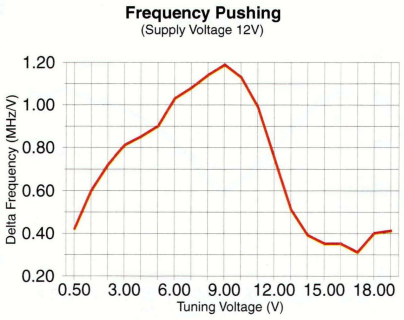


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	51.07	2130.76	2113.25	2097.92	4.15	3.00	1.64
1.00	40.59	2150.71	2133.55	2118.57	4.18	3.06	1.91
2.00	33.12	2184.89	2168.01	2153.14	4.29	3.08	1.96
3.00	30.35	2215.67	2198.87	2183.99	4.55	3.38	2.19
4.00	29.31	2245.17	2228.37	2213.40	5.07	3.69	2.49
5.00	29.37	2274.68	2257.67	2242.55	5.65	4.39	3.03
6.00	30.29	2304.97	2287.73	2272.34	5.75	4.70	3.68
7.00	31.69	2336.55	2319.05	2303.44	5.75	4.77	3.83
8.00	33.69	2369.95	2352.21	2336.24	5.61	4.71	3.91
9.00	35.75	2405.35	2387.43	2371.14	6.00	4.79	3.85
10.00	37.54	2442.51	2424.54	2408.13	6.49	5.51	4.44
11.00	38.72	2481.04	2462.93	2446.38	6.60	5.71	4.92
12.00	38.97	2519.91	2501.91	2485.21	6.22	5.81	5.18
13.00	37.93	2558.21	2540.17	2523.43	6.27	5.46	4.87
14.00	36.43	2595.45	2576.97	2559.82	6.47	5.79	5.11
15.00	34.18	2630.50	2611.72	2594.11	6.86	6.13	5.44
16.00	31.37	2663.11	2643.73	2625.64	6.74	6.48	5.89
17.00	28.69	2693.32	2673.08	2654.33	6.42	6.24	6.05
18.00	26.15	2720.94	2700.01	2680.62	6.39	6.13	5.80
19.00	23.79	2746.13	2724.40	2704.48	6.37	6.12	5.75



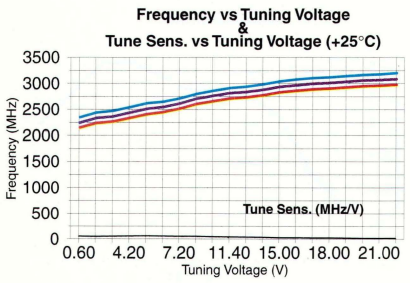


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-8.16	-18.83	-24.83	0.42
1.00	-8.17	-19.17	-23.83	0.60
2.00	-8.50	-19.50	-24.50	0.72
3.00	-9.00	-20.16	-26.83	0.81
4.00	-9.34	-20.67	-31.00	0.85
5.00	-9.67	-21.00	-33.50	0.90
6.00	-9.67	-20.67	-32.17	1.03
7.00	-10.34	-21.17	-31.34	1.08
8.00	-11.00	-21.34	-32.67	1.14
9.00	-10.83	-21.17	-30.83	1.19
10.00	-10.66	-21.00	-28.00	1.13
11.00	-11.16	-21.66	-26.33	0.99
12.00	-11.17	-22.83	-25.00	0.75
13.00	-11.50	-22.50	-26.84	0.51
14.00	-11.67	-24.34	-29.34	0.39
15.00	-12.00	-26.83	-29.17	0.35
16.00	-12.00	-28.17	-27.83	0.35
17.00	-11.83	-26.83	-29.00	0.31
18.00	-12.00	-25.34	-30.00	0.40
19.00	-12.83	-26.50	-31.17	0.41

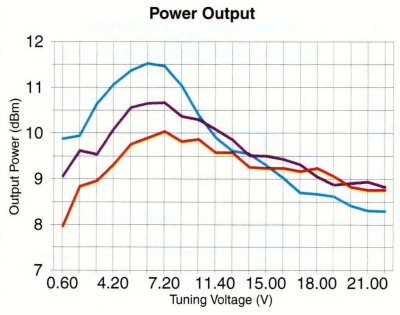


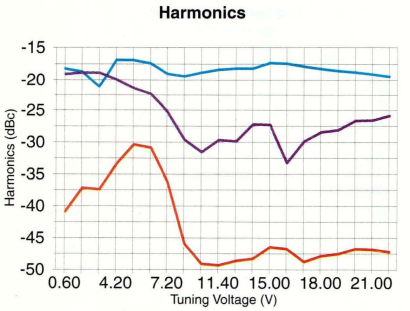
ROS-3000V

Linear Tuning - spec pg. 58

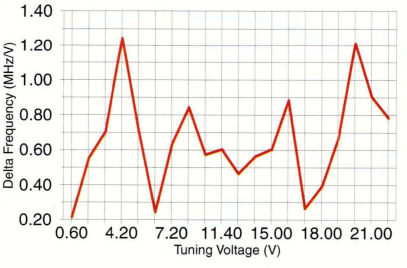


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.60	55.30	2266.91	2234.04	2214.02	9.86	9.04	7.95
2.40	49.57	2358.16	2323.74	2300.87	9.93	9.60	8.82
3.00	53.12	2391.99	2355.61	2330.97	10.63	9.52	8.94
4.20	59.82	2464.86	2426.83	2399.67	11.05	10.07	9.30
5.40	62.22	2537.46	2501.51	2472.92	11.35	10.54	9.74
6.00	57.65	2570.73	2536.10	2509.56	11.51	10.64	9.88
7.20	54.50	2630.80	2602.40	2577.86	11.45	10.65	10.02
9.00	51.00	2718.97	2695.20	2669.57	11.03	10.35	9.80
10.20	45.32	2780.03	2751.73	2724.40	10.39	10.28	9.85
11.40	42.05	2834.50	2803.57	2773.77	9.90	10.07	9.56
12.00	39.22	2858.83	2827.10	2797.17	9.60	9.84	9.56
13.20	35.43	2904.79	2870.36	2839.40	9.54	9.50	9.24
15.00	29.22	2962.34	2927.45	2895.17	9.29	9.49	9.22
16.20	24.77	2995.90	2958.86	2926.91	9.01	9.42	9.22
17.40	23.63	3025.40	2988.26	2954.79	8.69	9.30	9.15
18.00	22.80	3038.48	3001.94	2967.69	8.66	9.03	9.22
19.20	19.47	3062.49	3026.54	2991.95	8.61	8.86	9.04
20.40	17.53	3086.38	3048.77	3013.40	8.41	8.89	8.81
21.00	15.85	3098.42	3058.28	3022.95	8.30	8.92	8.74
22.20	15.03	3118.64	3076.86	3039.90	8.29	8.81	8.74



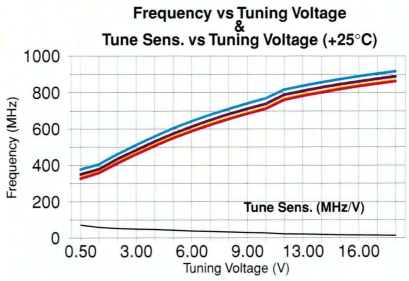


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.60	-18.30	-19.15	-40.92	0.21
2.40	-18.77	-18.90	-37.26	0.55
3.00	-21.18	-18.94	-37.50	0.70
4.20	-17.00	-20.02	-33.45	1.24
5.40	-17.01	-21.42	-30.43	0.71
6.00	-17.52	-22.43	-30.93	0.24
7.20	-19.08	-25.36	-36.32	0.63
9.00	-19.49	-29.70	-45.98	0.84
10.20	-18.90	-31.64	-49.20	0.57
11.40	-18.45	-29.72	-49.40	0.60
12.00	-18.27	-29.93	-48.68	0.46
13.20	-18.27	-27.27	-48.37	0.56
15.00	-17.44	-27.36	-46.53	0.60
16.20	-17.53	-33.32	-46.83	0.88
17.40	-17.98	-29.93	-48.85	0.26
18.00	-18.35	-28.52	-47.93	0.39
19.20	-18.64	-28.18	-47.60	0.66
20.40	-18.84	-26.68	-46.84	1.21
21.00	-19.16	-26.63	-46.92	0.90
22.20	-19.52	-25.97	-47.29	0.78

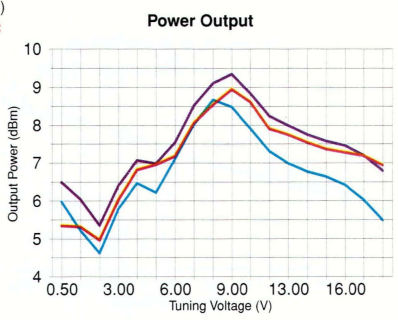


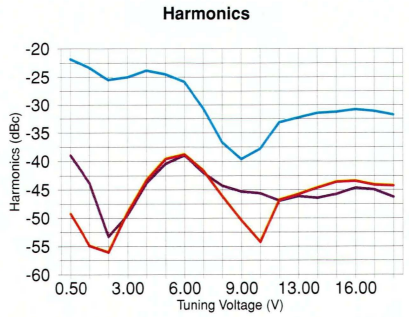
JTOS-850VW

Linear Tuning - spec pg. 59



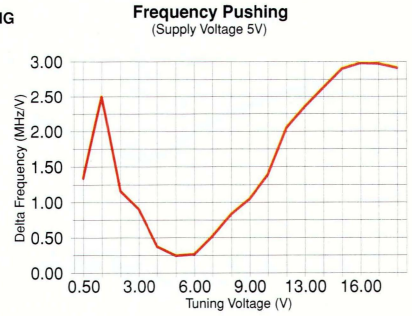
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	71.96	366.38	355.68	349.01	6.00	6.52	5.37
1.00	58.97	393.77	385.16	380.30	5.24	6.07	5.34
2.00	52.59	448.83	439.44	433.98	4.64	5.38	4.99
3.00	48.53	498.80	488.55	482.39	5.81	6.43	6.05
4.00	46.26	547.11	535.62	528.32	6.49	7.09	6.84
5.00	42.18	591.08	578.72	570.49	6.24	7.01	6.98
6.00	37.97	630.57	617.97	609.06	7.12	7.56	7.20
7.00	35.42	666.84	654.03	644.73	8.04	8.54	8.08
8.00	32.27	699.80	687.10	677.50	8.69	9.13	8.56
9.00	29.33	729.67	717.14	707.32	8.50	9.37	8.97
10.00	27.12	757.01	744.77	734.76	7.94	8.87	8.64
12.00	22.79	805.03	793.55	783.42	7.33	8.27	7.93
13.00	20.60	826.02	814.71	804.69	7.01	8.02	7.77
14.00	18.71	845.12	833.90	823.95	6.79	7.78	7.56
15.00	16.94	862.40	851.26	841.51	6.66	7.60	7.39
16.00	15.37	878.01	866.99	857.49	6.44	7.48	7.30
17.00	14.11	892.15	881.42	872.10	6.05	7.23	7.21
18.00	12.92	905.11	894.66	885.40	5.51	6.82	6.96





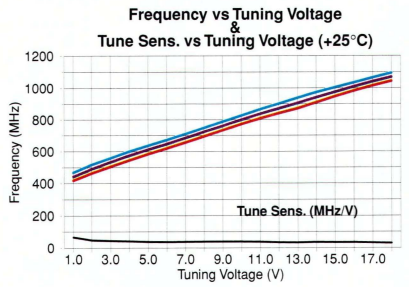
V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-21.66	-38.83	-49.16
1.00	-23.17	-43.67	-54.84
2.00	-25.33	-53.17	-56.00
3.00	-24.84	-49.34	-48.84
4.00	-23.67	-43.67	-43.17
5.00	-24.33	-40.33	-39.50
6.00	-25.67	-38.84	-38.67
7.00	-30.50	-41.84	-41.50
8.00	-36.50	-44.17	-46.00
9.00	-39.50	-45.17	-50.34
10.00	-37.67	-45.50	-54.17
12.00	-33.00	-46.83	-46.67
13.00	-32.17	-46.00	-45.67
14.00	-31.34	-46.34	-44.50
15.00	-31.16	-45.66	-43.50
16.00	-30.67	-44.50	-43.33
17.00	-31.00	-44.84	-44.00
18.00	-31.67	-46.17	-44.17

FREQ. PUSHING (MHz/V)
1.35
2.51
1.17
0.91
0.38
0.25
0.27
0.53
0.84
1.06
1.40
2.06
2.36
2.64
2.91
2.99
2.98
2.92

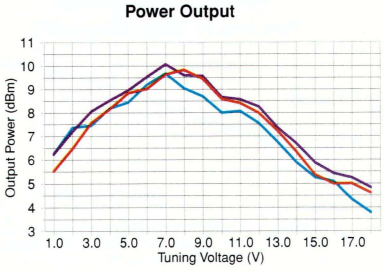


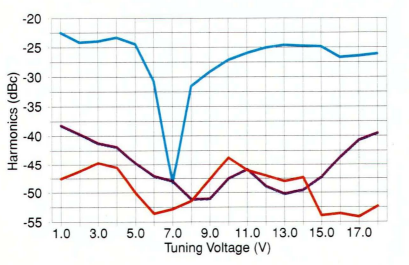
JTOS-1000W

Linear Tuning - spec pg. 59



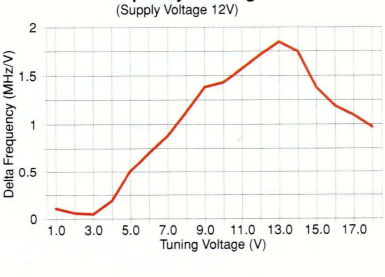
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	65.31	455.40	443.44	433.76	6.26	6.25	5.53
2.0	47.64	503.88	491.08	480.00	7.39	7.21	6.47
3.0	43.38	546.43	534.46	521.76	7.47	8.06	7.56
4.0	41.23	587.53	575.68	562.24	8.20	8.54	8.16
5.0	37.18	624.47	612.87	600.23	8.46	8.97	8.85
6.0	36.00	660.47	648.87	636.80	9.22	9.54	9.03
7.0	36.98	697.54	685.84	673.93	9.70	10.08	9.64
8.0	38.32	736.41	724.17	711.94	9.07	9.62	9.84
9.0	39.19	775.71	763.36	750.82	8.72	9.58	9.46
10.0	38.93	815.33	802.29	789.02	8.02	8.68	8.60
11.0	37.42	854.60	839.71	825.08	8.08	8.58	8.42
12.0	33.97	889.31	873.67	857.98	7.57	8.27	7.99
13.0	33.20	925.48	906.87	889.55	6.77	7.37	7.23
14.0	35.13	960.60	942.00	925.73	5.90	6.70	6.35
15.0	33.97	991.30	975.97	963.00	5.27	5.88	5.37
16.0	34.17	1022.17	1010.14	999.00	5.11	5.44	4.99
17.0	32.21	1052.63	1042.35	1031.78	4.35	5.25	5.01
18.0	28.65	1081.03	1070.99	1060.58	3.80	4.85	4.62





V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-22.44	-38.27	-47.61
2.0	-24.11	-39.78	-46.28
3.0	-23.91	-41.25	-44.75
4.0	-23.27	-41.94	-45.61
5.0	-24.44	-44.78	-50.11
6.0	-30.66	-47.16	-53.66
7.0	-48.22	-48.05	-52.89
8.0	-31.50	-51.17	-51.50
9.0	-29.10	-51.10	-47.76
10.0	-27.10	-47.60	-43.77
11.0	-25.95	-45.95	-46.12
12.0	-25.08	-48.92	-47.08
13.0	-24.57	-50.24	-48.07
14.0	-24.75	-49.58	-47.41
15.0	-24.87	-47.37	-54.03
16.0	-26.67	-43.67	-53.67
17.0	-26.42	-40.76	-54.26
18.0	-26.09	-39.59	-52.42

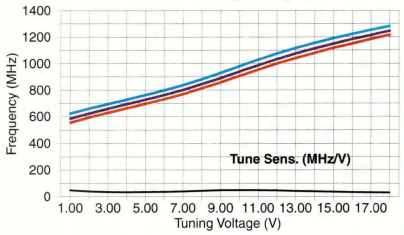
FREQ. PUSHING (MHz/V)
0.10
0.05
0.04
0.19
0.51
0.70
0.88
1.12
1.38
1.43
1.57
1.71
1.85
1.75
1.38
1.19
1.09
0.97



ROS-1200W

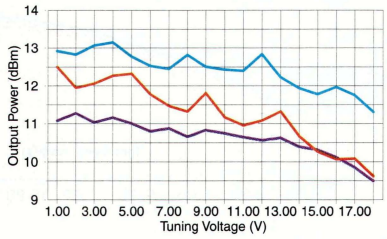
Linear Tuning - spec pg. 59

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

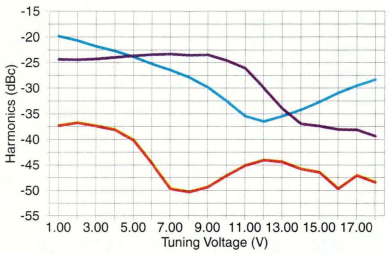


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	47.12	598.64	582.01	569.22	12.91	11.06	12.48
2.00	37.64	636.03	619.65	607.12	12.82	11.26	11.93
3.00	34.64	670.50	654.29	641.99	13.06	11.01	12.04
4.00	33.78	704.46	688.07	675.30	13.14	11.14	12.25
5.00	34.25	739.39	722.33	709.75	12.77	10.99	12.30
6.00	36.07	775.44	758.40	745.61	12.52	10.78	11.76
7.00	38.84	815.21	797.24	783.95	12.44	10.86	11.45
8.00	43.70	859.59	840.94	827.33	12.81	10.64	11.30
9.00	47.04	907.79	887.98	873.63	12.50	10.81	11.79
10.00	48.70	957.54	936.68	922.09	12.42	10.73	11.15
11.00	48.29	1006.88	984.96	969.49	12.39	10.63	10.93
12.00	45.74	1052.66	1030.70	1015.18	12.83	10.55	11.06
13.00	41.80	1094.91	1072.50	1056.86	12.22	10.61	11.30
14.00	38.36	1133.33	1110.86	1095.63	11.93	10.38	10.65
15.00	35.82	1168.29	1146.68	1131.71	11.77	10.30	10.25
16.00	33.41	1200.85	1180.09	1165.90	11.96	10.10	10.05
17.00	31.77	1231.20	1211.87	1198.68	11.74	9.84	10.06
18.00	30.13	1259.63	1241.99	1229.94	11.30	9.48	9.60

Power Output



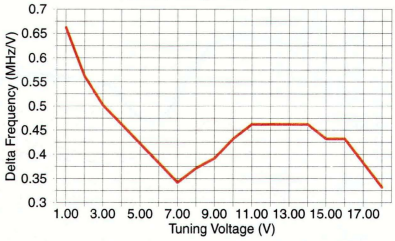
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-19.95	-24.48	-37.49
2.00	-20.83	-24.55	-36.94
3.00	-21.93	-24.41	-37.55
4.00	-22.85	-24.11	-38.30
5.00	-23.97	-23.81	-40.38
6.00	-25.35	-23.56	-44.83
7.00	-26.54	-23.45	-49.80
8.00	-28.01	-23.68	-50.47
9.00	-29.97	-23.61	-49.48
10.00	-32.61	-24.70	-47.25
11.00	-35.58	-26.24	-45.26
12.00	-36.67	-30.11	-44.19
13.00	-35.63	-34.11	-44.53
14.00	-34.37	-37.14	-45.92
15.00	-32.82	-37.55	-46.61
16.00	-31.07	-38.22	-49.81
17.00	-29.62	-38.30	-47.23
18.00	-28.42	-39.50	-48.55

V TUNE	FREQ. PUSHING (MHz/V)
1.00	0.66
2.00	0.56
3.00	0.50
4.00	0.46
5.00	0.42
6.00	0.38
7.00	0.34
8.00	0.37
9.00	0.39
10.00	0.43
11.00	0.46
12.00	0.46
13.00	0.46
14.00	0.46
15.00	0.43
16.00	0.43
17.00	0.38
18.00	0.33

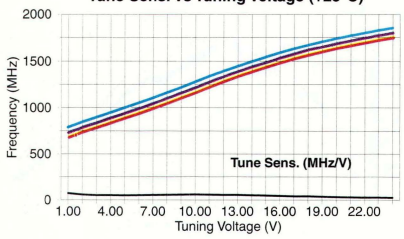
Frequency Pushing (Supply Voltage 12V)



ROS-1700W

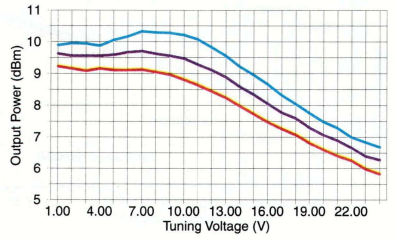
Linear Tuning - spec pg. 59

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

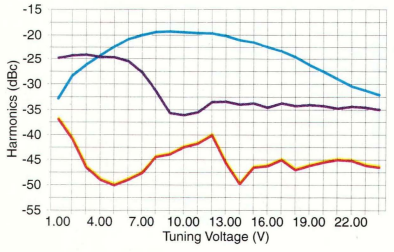


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	72.21	717.99	698.31	686.70	9.87	9.61	9.21
2.00	57.41	774.24	755.73	744.68	9.93	9.54	9.14
3.00	51.80	825.68	807.53	796.55	9.92	9.54	9.07
4.00	50.48	876.46	858.01	846.82	9.85	9.54	9.14
5.00	49.81	926.86	907.82	896.43	10.03	9.57	9.09
6.00	50.92	978.23	958.74	946.84	10.14	9.65	9.09
7.00	52.81	1031.26	1011.54	999.24	10.30	9.69	9.10
8.00	55.62	1087.44	1067.16	1054.55	10.27	9.60	9.03
9.00	57.92	1146.06	1125.08	1112.31	10.25	9.54	8.95
10.00	59.59	1205.42	1184.67	1172.03	10.19	9.45	8.79
11.00	59.04	1263.98	1243.71	1231.35	10.05	9.27	8.62
12.00	56.99	1319.63	1300.70	1289.01	9.80	9.09	8.43
13.00	53.96	1372.27	1354.66	1343.65	9.53	8.87	8.22
14.00	51.27	1422.56	1405.93	1395.45	9.20	8.57	7.96
15.00	48.93	1471.01	1451.86	1444.45	8.93	8.32	7.71
16.00	45.89	1516.40	1500.75	1490.55	8.64	8.03	7.45
17.00	42.66	1558.84	1543.41	1533.21	8.30	7.75	7.24
18.00	39.47	1597.98	1585.88	1572.71	8.02	7.57	7.05
19.00	36.01	1633.81	1618.89	1608.74	7.73	7.28	6.79
20.00	33.62	1667.41	1652.51	1642.26	7.46	7.05	6.58
21.00	31.30	1698.53	1683.81	1673.57	7.27	6.87	6.38
22.00	29.01	1727.54	1712.82	1702.64	6.97	6.64	6.23
23.00	27.20	1754.81	1740.02	1729.73	6.81	6.37	5.96
24.00	25.41	1780.22	1765.43	1755.05	6.66	6.25	5.80

Power Output



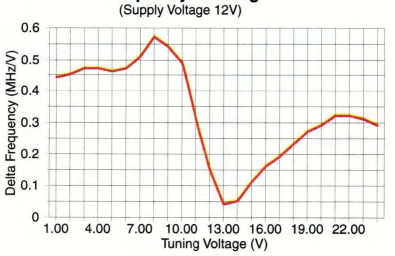
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
1.00	-32.97	-24.94	-37.01
2.00	-28.53	-24.38	-40.92
3.00	-26.31	-24.24	-46.58
4.00	-24.39	-24.70	-49.09
5.00	-22.59	-24.80	-50.20
6.00	-20.94	-25.58	-49.09
7.00	-20.15	-27.83	-47.77
8.00	-19.53	-31.49	-44.55
9.00	-19.44	-35.77	-44.03
10.00	-19.61	-36.21	-42.59
11.00	-19.74	-35.63	-41.85
12.00	-19.84	-33.60	-40.22
13.00	-20.33	-33.52	-45.70
14.00	-21.14	-34.10	-49.94
15.00	-21.65	-33.86	-46.61
16.00	-22.64	-34.68	-46.33
17.00	-23.53	-33.82	-45.14
18.00	-24.77	-34.36	-47.10
19.00	-26.34	-34.18	-46.26
20.00	-27.68	-34.39	-45.61
21.00	-29.10	-34.85	-45.12
22.00	-30.55	-34.50	-45.32
23.00	-31.41	-34.70	-46.21
24.00	-32.25	-35.12	-46.58

V TUNE	FREQ. PUSHING (MHz/V)
1.00	0.44
2.00	0.45
3.00	0.47
4.00	0.47
5.00	0.46
6.00	0.47
7.00	0.51
8.00	0.57
9.00	0.54
10.00	0.49
11.00	0.31
12.00	0.15
13.00	0.04
14.00	0.05
15.00	0.11
16.00	0.16
17.00	0.19
18.00	0.23
19.00	0.27
20.00	0.29
21.00	0.32
22.00	0.32
23.00	0.31
24.00	0.29

Frequency Pushing (Supply Voltage 12V)

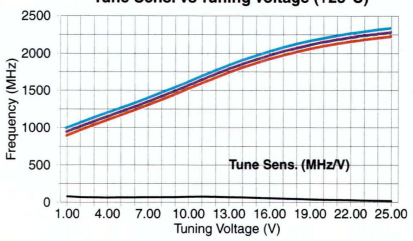


ROS-2150VW

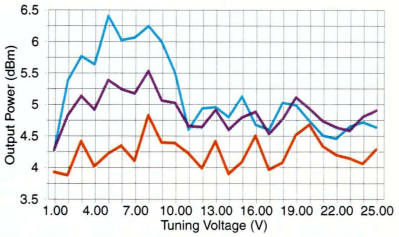
Linear Tuning - spec pg. 59

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	80.73	955.42	934.09	916.09	4.26	4.27	3.91
2.00	70.90	1025.58	1004.99	989.25	5.37	4.81	3.86
3.00	67.06	1091.78	1072.04	1057.71	5.76	5.12	4.40
4.00	64.88	1156.07	1136.93	1123.57	5.63	4.90	4.00
5.00	64.91	1220.32	1201.83	1189.14	6.40	5.37	4.20
6.00	66.54	1286.42	1268.38	1255.89	6.02	5.23	4.33
7.00	68.49	1354.82	1336.87	1324.51	6.06	5.16	4.09
8.00	70.51	1424.80	1407.38	1395.27	6.24	5.52	4.81
9.00	71.72	1495.25	1479.10	1467.63	5.99	5.05	4.38
10.00	75.82	1571.08	1554.92	1542.78	5.49	5.01	4.37
11.00	77.42	1650.56	1632.35	1618.68	4.59	4.64	4.21
12.00	74.70	1725.84	1707.04	1692.78	4.93	4.63	3.97
13.00	71.07	1797.08	1778.12	1763.58	4.95	4.90	4.40
14.00	66.67	1864.07	1844.78	1829.93	4.79	4.58	3.88
15.00	61.89	1926.53	1906.68	1891.24	5.12	4.78	4.07
16.00	56.77	1984.03	1963.44	1947.21	4.67	4.87	4.49
17.00	51.35	2036.01	2014.80	1997.77	4.59	4.52	3.95
18.00	46.32	2082.83	2061.12	2043.30	5.02	4.75	4.06
19.00	41.30	2124.64	2102.42	2083.86	4.98	5.10	4.50
20.00	36.90	2161.79	2139.32	2120.07	4.73	4.92	4.66
21.00	32.63	2194.67	2171.95	2152.28	4.50	4.72	4.32
22.00	29.07	2224.07	2201.02	2180.90	4.45	4.62	4.18
23.00	26.05	2250.28	2227.06	2206.43	4.64	4.57	4.13
24.00	23.24	2273.51	2250.30	2229.32	4.71	4.79	4.04
25.00	20.51	2294.13	2270.81	2249.59	4.63	4.89	4.27

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

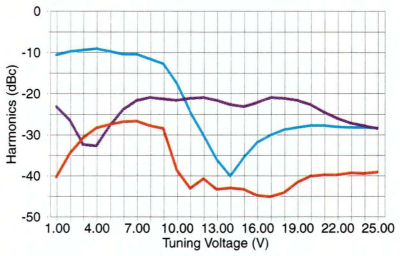


Power Output

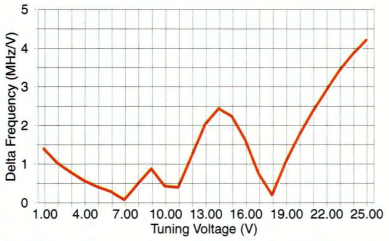


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-10.67	-23.34	-40.50	1.36
2.00	-9.84	-26.67	-34.67	1.00
3.00	-9.50	-32.50	-31.00	0.76
4.00	-9.17	-32.84	-28.50	0.54
5.00	-9.83	-27.83	-27.67	0.38
6.00	-10.50	-24.00	-27.00	0.26
7.00	-10.50	-21.83	-26.83	0.05
8.00	-11.66	-21.16	-28.00	0.45
9.00	-12.83	-21.50	-28.67	0.85
10.00	-17.67	-21.83	-38.83	0.40
11.00	-24.50	-21.34	-43.34	0.37
12.00	-30.17	-21.17	-40.84	1.18
13.00	-36.16	-21.83	-43.50	2.00
14.00	-40.17	-22.84	-43.17	2.41
15.00	-35.67	-23.34	-43.50	2.21
16.00	-32.00	-22.33	-45.00	1.60
17.00	-30.17	-21.17	-45.33	0.72
18.00	-28.84	-21.34	-44.34	0.17
19.00	-28.34	-21.84	-41.84	1.02
20.00	-27.83	-22.83	-40.33	1.71
21.00	-27.83	-24.67	-40.00	2.33
22.00	-28.17	-26.17	-40.00	2.86
23.00	-28.33	-27.33	-39.50	3.38
24.00	-28.34	-28.00	-39.67	3.83
25.00	-28.50	-28.67	-39.33	4.18

Harmonics



Frequency Pushing
(Supply Voltage 5V)

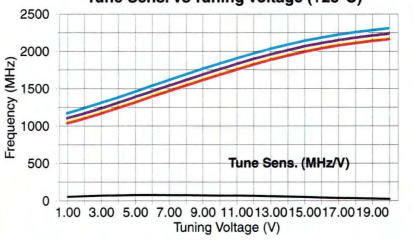


ROS-2160W

Linear Tuning - spec pg. 59

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.00	55.26	1107.56	1097.08	1085.42	5.10	5.37	5.20
2.00	61.50	1170.52	1158.58	1146.45	5.73	5.81	5.53
3.00	68.54	1239.85	1227.12	1214.84	6.13	6.11	5.69
4.00	73.50	1313.46	1300.62	1288.47	6.14	6.04	5.60
5.00	76.41	1390.85	1377.03	1364.71	5.51	5.59	5.29
6.00	78.06	1471.20	1455.09	1441.61	4.89	5.17	4.98
7.00	76.10	1548.29	1531.19	1516.93	4.89	5.12	4.97
8.00	74.11	1622.93	1605.30	1590.58	5.06	5.23	5.04
9.00	72.54	1695.36	1677.84	1663.13	5.29	5.38	5.11
10.00	71.59	1766.51	1749.43	1734.77	5.43	5.48	5.19
11.00	69.46	1835.75	1818.88	1804.23	5.52	5.66	5.38
12.00	66.29	1901.81	1885.18	1870.72	5.68	5.82	5.52
13.00	62.35	1963.92	1947.53	1933.02	5.69	5.89	5.64
14.00	56.70	2020.60	2004.23	1989.54	5.76	6.01	5.74
15.00	50.92	2071.22	2055.15	2040.30	5.67	5.98	5.82
16.00	44.38	2115.53	2099.53	2084.60	5.63	5.93	5.82
17.00	39.00	2154.21	2138.53	2123.30	5.48	5.91	5.88
18.00	33.49	2187.18	2172.02	2156.88	5.42	5.81	5.79
19.00	28.60	2215.56	2200.62	2185.55	5.37	5.80	5.75
20.00	24.82	2240.20	2225.44	2210.21	5.31	5.75	5.72

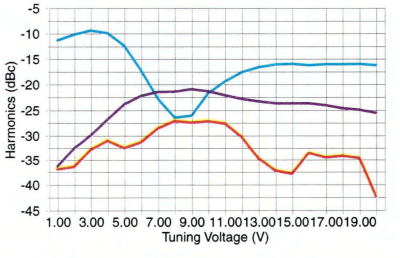
Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)



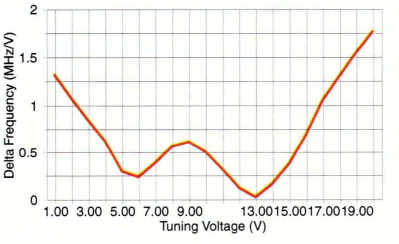
Power Output

V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.00	-11.39	-36.38	-36.92	1.31
2.00	-10.22	-32.56	-36.44	1.07
3.00	-9.43	-29.99	-32.88	0.84
4.00	-9.95	-26.86	-31.06	0.62
5.00	-12.44	-23.85	-32.56	0.29
6.00	-17.30	-22.27	-31.37	0.23
7.00	-22.89	-21.52	-28.63	0.38
8.00	-26.51	-21.46	-27.21	0.56
9.00	-26.15	-20.99	-27.51	0.61
10.00	-21.77	-21.42	-27.22	0.50
11.00	-19.42	-22.14	-27.70	0.31
12.00	-17.59	-22.88	-30.37	0.12
13.00	-16.64	-23.32	-34.73	0.02
14.00	-16.13	-23.74	-37.25	0.16
15.00	-16.03	-23.73	-37.89	0.37
16.00	-16.27	-23.73	-33.63	0.69
17.00	-16.08	-24.11	-34.58	1.05
18.00	-16.07	-24.70	-34.24	1.30
19.00	-16.04	-24.98	-34.68	1.54
20.00	-16.28	-25.59	-42.30	1.76

Harmonics



Frequency Pushing
(Supply Voltage 10V)



VOLTAGE CONTROLLED OSCILLATORS

5V TUNING FOR PLL ICs ❑ SURFACE MOUNT

24 to 2700MHz

MODEL◆ NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
JTOS-50P	24-29		+9.5	-88	-108	-127	-147	0.06	0.04	2-2.5	-14	-12	50	12	20	84	BK377	jc	14.95
JTOS-75P	35-43		+9.0	-89	-110	-130	-140	0.15	0.11	2.5-4	-25	-20	125	12	20	84	BK377	jc	14.95
JTOS-100P	48-59		+9.0	-83	-108	-128	-140	0.6	0.2	3.5-4	-30	-20	100	12	18	85	BK377	jc	14.95
JTOS-150P	72-91		+9.5	-82	-106	-127	-147	0.8	0.3	6-9	-30	-17	112	12	20	85	BK377	jc	14.95
JTOS-200P	95-120		+8.8	-84	-105	-124	-145	1.0	0.2	7-10	-30	-20	110	12	20	86	BK377	jc	14.95
JTOS-300P	148-174		+10.0	-82	-102	-122	-142	1.0	0.2	10-14	-27	-20	120	12	20	86	BK377	jc	16.95
JTOS-400P	194-220		+11.0	-82	-102	-122	-142	1.4	0.4	13-18	-25	-20	130	12	20	87	BK377	jc	16.95
JTOS-535P	278-325		+9.5	-75	-97	-117	-137	2.0	0.5	17-22	-30	-20	115	12	20	87	BK377	jc	16.95
JTOS-765P	486-510		+9.0	-75	-98	-118	-138	2.0	0.5	20-30	-30	-20	100	12	20	88	BK377	jc	17.95
JTOS-1025P	680-775		+9.0	-70	-94	-114	-134	5.0	0.6	30-40	-27	-20	100	12	22	88	BK377	jc	19.95
JTOS-2200PA	2000-2200		+6.0	-65	-92	-112	-132	15.0	5.0	110-170	-22	-12	10000	5	25	89	BK377	jc	21.95
JTOS-3000P	2300-2600		+11.0	-65	-92	-112	-132	50.0	5.0	120-160	-22	-12	20000	5	25	89	BK377	jc	21.95
MOS-1826PV	1760-1826		+2.0	-75	-101	-122	-142	8.0	1.0	21-35	-28	-15	10000	5	25	90	CZ682	my	19.95
ROS-205PV	180-210		+2.0	-88	-110	-131	-151	0.4	0.4	10-15	-30	-20	2000	5	15	90	CK605	kg	17.95
ROS-285PV	245-285		+3.0	-80	-100	-120	-140	2.0	0.2	10-20	-20	-10	100	5	20	91	CK605	kg	17.95
ROS-550PV	450-550		+6.0	-81	-104	-124	-144	3.0	0.5	30-60	-15	--	8000	6	16	91	CK605	kg	19.95
ROS-660PV	640-660		0	-85	-107	-127	-147	0.8	0.6	10-14	-17	-12	2000	5	15	92	CK605	kg	19.95
ROS-675PV	655-675		0	-86	-107	-127	-146	1.0	0.5	10-14	-23	-10	5000	6	15	92	CK605	kg	19.95
ROS-725PV	710-725		0	-85	-105	-126	-145	0.9	0.3	8-13	-19	-12	2000	5	15	93	CK605	kg	19.95
ROS-740PV	720-740		0	-84	-106	-126	-145	1.0	0.8	10-14	-16	-10	5000	5	15	93	CK605	kg	19.95
ROS-900PV	810-900		+1.0	-80	-102	-122	-142	3.0	2.0	26-30	-25	-16	1000	4.5	12	94	CK605	kg	19.95
ROS-960PV	890-960		0	-80	-102	-122	-142	2.0	0.2	25-28	-27	-18	1000	5	12	94	CK605	kg	19.95
ROS-1000PV	900-1000		+6.0	-80	-104	-124	-144	2.0	0.7	27-38	-33	-20	1000	5	22	95	CK605	kg	19.95
ROS-1435PV	1375-1435		+3.0	-78	-101	-121	-141	4.0	1.7	20-30	-26	-18	5000	5	20	95	CK605	kg	19.95
ROS-1600PV	1520-1600		+7.0	-75	-100	-120	-140	10.0	3.0	25-38	-26	-16	1000	5	25	96	CK605	kg	18.95
ROS-1605PV	1500-1605		0	-74	-98	-118	-138	6.0	0.8	40-50	-17	-8	8000	3.3	16	96	CK605	kg	19.95

TUNING VOLTAGE TO COVER FREQUENCY RANGE 0.5V TO 5V

NOTES:

❑ Surface Mount Non-hermetic

◆ Aqueous washable.

A. General Quality Control Procedures, Environmental specifications, Hi-Rel, and MIL description are given in Mini-Circuits RF/IF Designer's Guide.

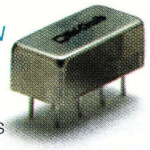
B. Connector types, case mounted options,and case finishes are given with "Outline Drawings & Case Style Dimensions" on pages 112 and 113.

C. Environmental specifications and re-flow soldering Information available in mini-circuits RF/IF Designer's Guide.

D. Prices and Specifications subject to change without notice.
1. Absolute Maximum Supply Voltage (V_{CC}) & Tuning Voltage (V_{tune}):
2. Operating Temperature: -55°C to +85°C

Model	(V_{CC})	(V_{tune})	Model	(V_{CC})	(V_{tune})
JTOS-50P thru JTOS-1025P	+16V	+7V	ROS-285PV	+8V	+10V
JTOS-2200PA	+6V	+6V	ROS-660PV thru-1600PV	+6V	+6V
JTOS-3000P	+7V	+7V	ROS-1605PV, -1650	+3.5V	+6V
MOS-1826PV	+6V	+6V	Other ROS Models	+13V	+18V
ROS-205PV	+6V	+6V	POS Models	+16V	+7V

PLUG-IN



24 to 755MHz

POS

MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (5-49)
POS-50P	24-29		+10.0	-92	-113	-134	-151	0.06	0.04	2-2.5	-18	-12	50	12	20	97	A06	hx	12.95
POS-75P	35-43		+9.0	-91	-113	-135	-151	0.15	0.11	2.5-4	-25	-20	100	12	20	97	A06	hx	12.95
POS-100P	48-59		+9.0	-92	-112	-134	-151	0.6	0.2	3.5-5	-30	-18	100	12	20	98	A06	hx	12.95
POS-150P	72-91		+10.0	-84	-104	-126	-147	0.8	0.3	6-9	-25	-17	100	12	20	98	A06	hx	12.95
POS-200P	95-120		+10.0	-77	-102	-123	-146	1.0	0.2	7-10	-30	-20	100	12	20	99	A06	hx	12.95
POS-300P	148-174		+10.0	-83	-105	-125	-145	1.8	0.3	10-14	-27	-20	100	12	20	99	A06	hx	14.95
POS-400P	194-220		+10.5	-82	-103	-124	-142	1.8	0.3	13-18	-25	-20	100	12	20	100	A06	hx	14.95
POS-535P	278-325		+10.0	-66	-95	-120	-138	2.0	0.4	17-22	-30	-20	100	12	20	100	A06	hx	14.95
POS-765P	486-510		+9.5	-70	-92	-116	-135	5.0	0.4	20-30	-26	-20	100	12	22	101	A06	hx	15.95
POS-1025P	680-755		+8.5	-74	-96	-116	-135	5.0	0.6	30-40	-24	-18	100	12	22	101	A06	hx	17.95

TUNING VOLTAGE TO COVER FREQUENCY RANGE 0.5V TO 5V

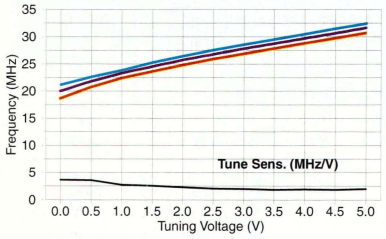
PIN CONNECTIONS see case style and outline drawings

PORT	jc	kg	hx	my
RF OUT	13	10	2	5
V-CC	2	14	1	3
V-TUNE	5	2	8	1
GND EXT	all others	all others	3,4,5,6,7	all others

JTOS-50P

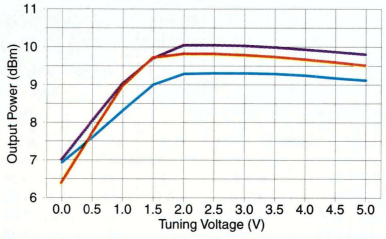
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

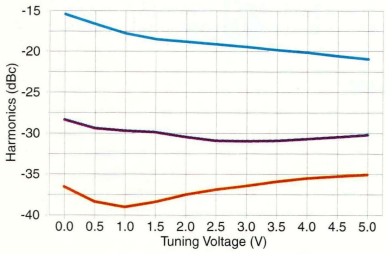


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	3.64	21.03	19.87	19.00	6.92	6.99	6.38
0.5	3.59	22.51	21.68	21.07	7.58	8.01	7.68
1.0	2.74	23.72	23.17	22.73	8.30	9.01	8.94
1.5	2.57	25.14	24.38	23.94	8.99	9.68	9.70
2.0	2.33	26.34	25.60	25.16	9.27	10.03	9.80
2.5	2.03	27.42	26.65	26.25	9.29	10.03	9.80
3.0	1.99	28.43	27.66	27.24	9.29	10.01	9.77
3.5	1.87	29.40	28.61	28.20	9.27	9.97	9.72
4.0	1.92	30.37	29.58	29.14	9.23	9.91	9.65
4.5	1.85	31.34	30.52	30.08	9.16	9.85	9.58
5.0	1.97	32.32	31.49	31.03	9.10	9.78	9.50

Power Output



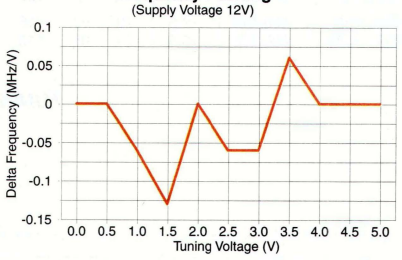
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-15.51	-28.42	-36.61
0.5	-16.74	-29.48	-38.42
1.0	-17.90	-29.78	-39.10
1.5	-18.60	-29.95	-38.48
2.0	-18.92	-30.54	-37.60
2.5	-19.22	-31.00	-36.99
3.0	-19.57	-31.04	-36.50
3.5	-19.95	-31.01	-35.98
4.0	-20.26	-30.78	-35.60
4.5	-20.69	-30.54	-35.34
5.0	-21.04	-30.28	-35.11

FREQ. PUSHING (MHz/V)
0.00
0.00
-0.06
-0.13
0.00
-0.06
-0.06
0.06
0.00
0.00
0.00

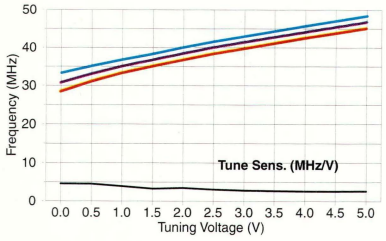
Frequency Pushing (Supply Voltage 12V)



JTOS-75P

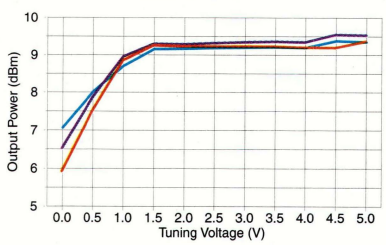
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

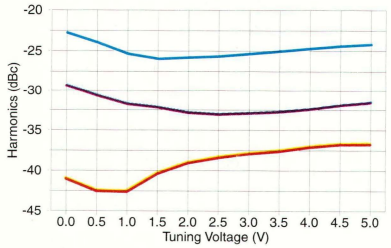


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	4.56	31.69	30.60	29.65	7.04	6.52	5.91
0.5	4.50	33.49	32.86	32.22	7.99	7.85	7.50
1.0	3.92	35.18	34.90	34.44	8.68	8.94	8.84
1.5	3.26	36.74	36.61	36.22	9.13	9.28	9.24
2.0	3.43	38.45	38.30	37.90	9.14	9.27	9.21
2.5	3.04	39.99	39.86	39.51	9.16	9.30	9.21
3.0	2.80	41.40	41.28	40.95	9.17	9.33	9.21
3.5	2.69	42.76	42.63	42.32	9.18	9.34	9.21
4.0	2.63	44.10	43.96	43.66	9.17	9.33	9.19
4.5	2.61	45.43	45.26	44.98	9.35	9.53	9.18
5.0	2.64	46.78	46.59	46.30	9.33	9.51	9.35

Power Output



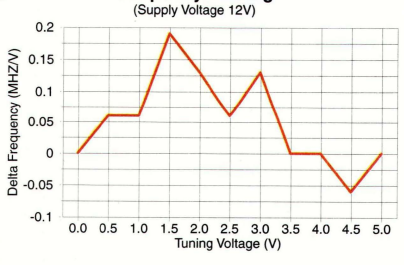
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-22.90	-29.40	-41.07
0.5	-24.07	-30.73	-42.57
1.0	-25.49	-31.82	-42.66
1.5	-26.11	-32.27	-40.44
2.0	-25.93	-32.93	-39.10
2.5	-25.79	-33.13	-38.46
3.0	-25.49	-32.99	-37.99
3.5	-25.17	-32.83	-37.67
4.0	-24.82	-32.49	-37.16
4.5	-24.50	-32.00	-36.83
5.0	-24.31	-31.65	-36.81

FREQ. PUSHING (MHz/V)
0.00
0.06
0.06
0.19
0.13
0.06
0.13
0.00
0.00
-0.06
0.00

Frequency Pushing (Supply Voltage 12V)



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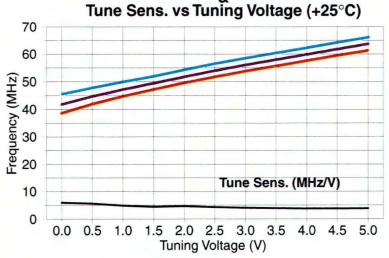
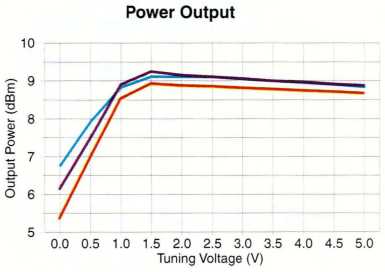
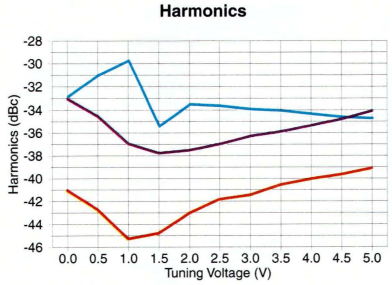
5V Tuning For PLL ICs- spec pg. 82



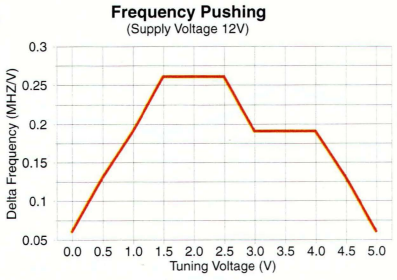
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	5.93	43.34	41.46	40.21	6.74	6.13	5.35
0.5	5.63	45.64	44.35	43.52	7.91	7.47	6.96
1.0	4.88	47.75	46.87	46.32	8.81	8.88	8.52
1.5	4.47	49.80	49.15	48.75	9.09	9.22	8.91
2.0	4.68	52.13	51.45	51.10	9.08	9.13	8.86
2.5	4.35	54.35	53.69	53.32	9.08	9.09	8.84
3.0	4.02	56.37	55.73	55.34	9.02	9.04	8.80
3.5	3.87	58.30	57.68	57.28	8.98	8.98	8.77
4.0	3.80	60.19	59.59	59.18	8.93	8.95	8.73
4.5	3.79	62.07	61.49	61.06	8.88	8.90	8.70
5.0	3.84	63.98	63.41	62.97	8.82	8.86	8.66





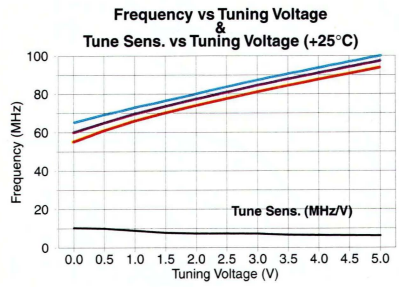
V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-32.96	-33.12	-41.12
0.5	-31.13	-34.63	-42.80
1.0	-29.85	-37.02	-45.35
1.5	-35.52	-37.86	-44.86
2.0	-33.60	-37.60	-43.10
2.5	-33.73	-37.06	-41.89
3.0	-34.02	-36.35	-41.52
3.5	-34.13	-35.96	-40.63
4.0	-34.43	-35.43	-40.10
4.5	-34.71	-34.88	-39.71
5.0	-34.84	-34.17	-39.17

FREQ. PUSHING (MHz/V)
0.06
0.13
0.19
0.26
0.26
0.26
0.19
0.19
0.19
0.13
0.06

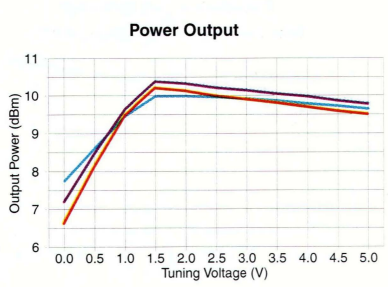


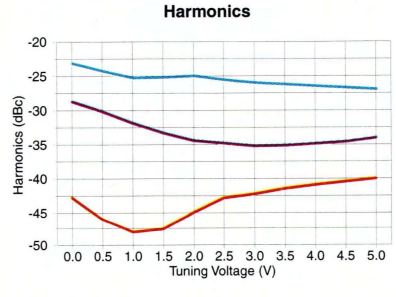
JTOS-150P

5V Tuning For PLL ICs- spec pg. 82



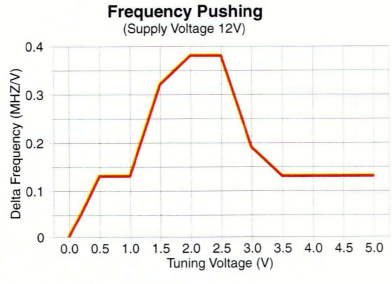
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	10.24	63.31	59.60	57.51	7.72	7.18	6.61
0.5	9.99	67.21	64.66	63.26	8.59	8.46	8.11
1.0	8.82	70.96	69.22	68.25	9.43	9.62	9.45
1.5	7.70	74.52	73.21	72.43	9.95	10.36	10.19
2.0	7.36	78.14	76.93	76.19	9.95	10.30	10.11
2.5	7.32	81.92	80.54	79.77	9.93	10.19	9.97
3.0	7.12	85.50	84.18	83.40	9.89	10.12	9.88
3.5	6.61	88.81	87.54	86.76	9.83	10.03	9.79
4.0	6.36	91.97	90.75	89.97	9.75	9.95	9.68
4.5	6.24	95.04	93.89	93.10	9.69	9.84	9.57
5.0	6.18	98.10	96.99	96.21	9.61	9.76	9.49





V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-23.33	-28.83	-42.83
0.5	-24.44	-30.27	-46.11
1.0	-25.46	-31.96	-48.13
1.5	-25.37	-33.37	-47.70
2.0	-25.17	-34.51	-45.01
2.5	-25.73	-34.90	-42.90
3.0	-26.16	-35.33	-42.33
3.5	-26.40	-35.24	-41.57
4.0	-26.66	-34.99	-40.99
4.5	-26.88	-34.71	-40.55
5.0	-27.11	-34.11	-40.11

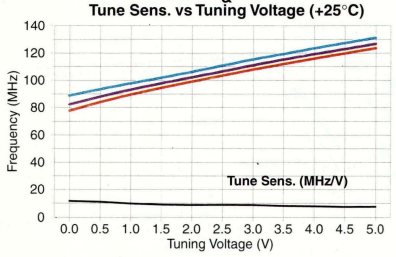
FREQ. PUSHING (MHz/V)
0.00
0.13
0.13
0.32
0.38
0.38
0.19
0.13
0.13
0.13
0.13



JTOS-200P

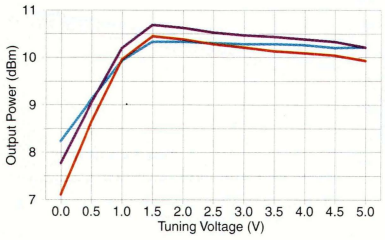
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

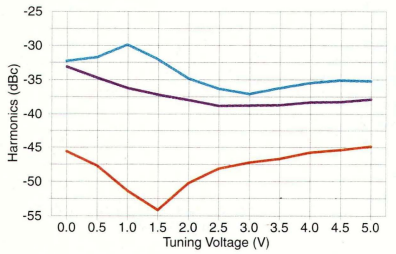


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	11.60	87.77	83.24	80.40	8.25	7.79	7.13
0.5	11.10	92.32	88.92	86.83	9.13	9.06	8.66
1.0	9.79	96.60	93.96	92.34	9.95	10.22	9.98
1.5	8.99	100.73	98.54	97.18	10.35	10.71	10.47
2.0	8.77	104.99	103.01	101.73	10.35	10.65	10.40
2.5	8.89	109.57	107.36	106.12	10.32	10.55	10.30
3.0	8.75	114.11	111.84	110.50	10.30	10.49	10.23
3.5	8.14	118.25	115.96	114.62	10.30	10.46	10.15
4.0	7.95	122.24	119.97	118.56	10.28	10.40	10.11
4.5	7.60	126.11	123.82	122.40	10.22	10.35	10.06
5.0	7.72	129.94	127.66	126.28	10.23	10.23	9.95

Power Output



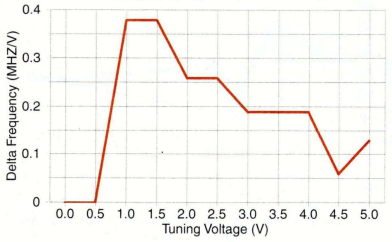
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-32.16	-33.00	-45.50
0.5	-31.60	-34.60	-47.60
1.0	-29.76	-36.09	-51.26
1.5	-31.90	-37.06	-54.06
2.0	-34.67	-37.84	-50.17
2.5	-36.20	-38.70	-48.03
3.0	-36.97	-38.64	-47.14
3.5	-36.08	-38.58	-46.58
4.0	-35.35	-38.18	-45.68
4.5	-34.97	-38.13	-45.30
5.0	-35.08	-37.75	-44.75

FREQ. PUSHING (MHz/V)
0.00
0.00
0.38
0.38
0.26
0.26
0.19
0.19
0.19
0.06
0.13

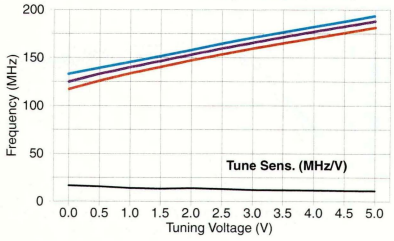
Frequency Pushing (Supply Voltage 12V)



JTOS-300P

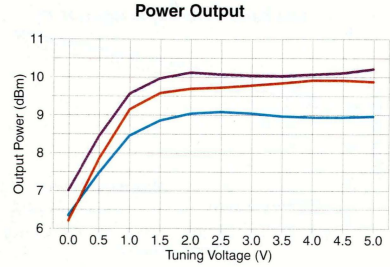
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

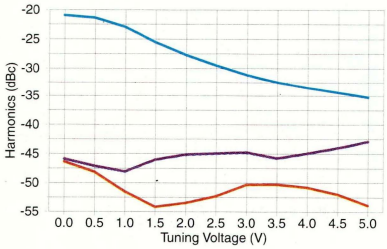


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	16.26	130.97	125.58	121.94	6.36	7.02	6.21
0.5	15.16	137.44	133.44	130.82	7.48	8.45	7.85
1.0	13.58	143.41	140.40	138.32	8.47	9.57	9.16
1.5	13.09	149.57	147.01	145.24	8.87	9.98	9.59
2.0	13.65	156.17	153.67	152.09	9.05	10.13	9.70
2.5	12.81	162.85	160.26	158.44	9.10	10.08	9.73
3.0	11.80	169.07	166.24	164.40	9.06	10.05	9.79
3.5	11.45	174.77	172.00	170.06	8.99	10.04	9.85
4.0	11.24	180.29	177.66	175.50	8.96	10.08	9.92
4.5	11.05	186.11	183.22	180.88	8.96	10.12	9.92
5.0	10.75	191.68	188.65	186.34	8.98	10.22	9.89

Power Output



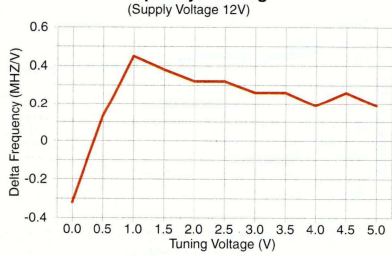
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-20.87	-45.87	-46.37
0.5	-21.30	-47.14	-48.14
1.0	-22.87	-48.04	-51.54
1.5	-25.50	-46.00	-54.17
2.0	-27.65	-45.15	-53.48
2.5	-29.45	-44.95	-52.29
3.0	-31.10	-44.77	-50.27
3.5	-32.42	-45.76	-50.26
4.0	-33.45	-44.95	-50.79
4.5	-34.33	-43.99	-51.99
5.0	-35.22	-42.89	-53.89

FREQ. PUSHING (MHz/V)
-0.32
0.13
0.45
0.38
0.32
0.32
0.26
0.26
0.19
0.26
0.19

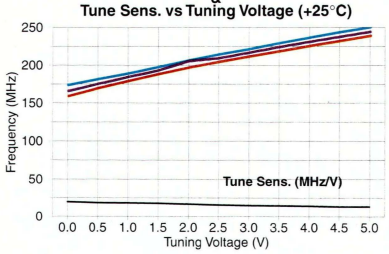
Frequency Pushing (Supply Voltage 12V)



JTOS-400P

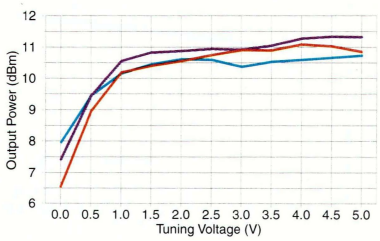
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

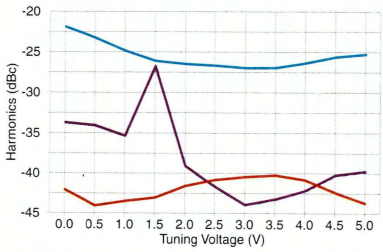


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	19.74	171.24	165.27	161.07	7.95	7.40	6.54
0.5	18.42	179.35	174.81	171.96	9.44	9.43	8.94
1.0	17.91	186.89	183.80	181.54	10.14	10.54	10.17
1.5	17.51	195.32	192.53	190.53	10.44	10.81	10.38
2.0	16.59	204.34	205.03	199.16	10.60	10.86	10.54
2.5	15.48	212.15	208.90	206.87	10.58	10.93	10.73
3.0	14.87	219.26	216.39	213.96	10.36	10.91	10.89
3.5	14.40	227.09	223.63	220.94	10.52	11.03	10.88
4.0	14.01	234.56	230.71	227.86	10.58	11.26	11.07
4.5	13.31	241.66	237.48	234.56	10.65	11.32	11.01
5.0	13.22	247.96	244.05	241.36	10.72	11.31	10.84

Power Output



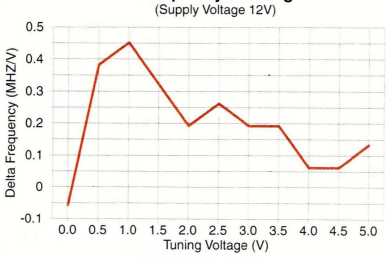
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-21.95	-33.78	-42.12
0.5	-23.31	-34.15	-44.15
1.0	-24.91	-35.41	-43.58
1.5	-26.14	-26.81	-43.14
2.0	-26.51	-39.17	-41.67
2.5	-26.73	-41.73	-40.90
3.0	-27.02	-44.02	-40.52
3.5	-26.97	-43.31	-40.31
4.0	-26.41	-42.24	-40.91
4.5	-25.64	-40.31	-42.48
5.0	-25.30	-39.80	-43.80

FREQ. PUSHING (MHz/V)
-0.06
0.38
0.45
0.32
0.19
0.26
0.19
0.19
0.06
0.06
0.13

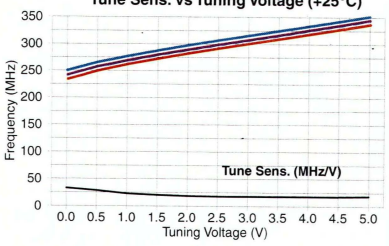
Frequency Pushing
(Supply Voltage 12V)



JTOS-535P

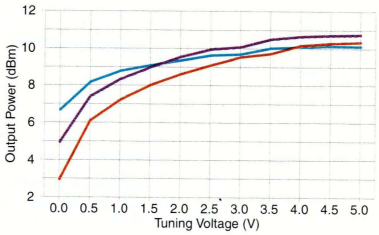
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

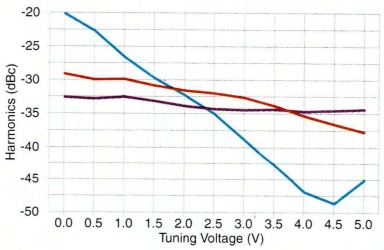


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	33.00	245.51	240.36	236.08	6.62	4.90	2.90
0.5	28.85	260.45	255.82	252.18	8.14	7.35	6.04
1.0	23.30	272.41	268.01	264.56	8.75	8.28	7.17
1.5	20.66	282.95	278.66	275.23	9.05	8.93	7.95
2.0	18.98	292.72	288.36	284.88	9.32	9.49	8.55
2.5	18.30	302.09	297.57	294.20	9.60	9.91	9.04
3.0	17.86	311.13	306.52	303.36	9.66	10.03	9.48
3.5	17.87	319.94	315.44	312.35	9.99	10.46	9.67
4.0	18.19	328.69	324.51	321.29	10.06	10.61	10.11
4.5	18.40	337.57	333.72	330.19	10.10	10.67	10.24
5.0	18.81	346.97	343.10	339.19	10.08	10.70	10.30

Power Output



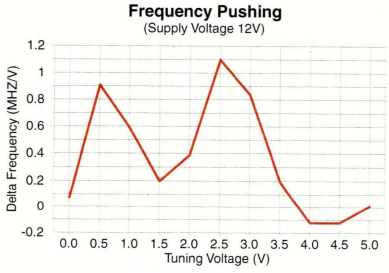
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-20.22	-32.72	-29.22
0.5	-22.78	-32.95	-30.11
1.0	-26.67	-32.67	-30.00
1.5	-29.81	-33.31	-30.98
2.0	-32.37	-34.04	-31.70
2.5	-35.13	-34.47	-32.13
3.0	-38.94	-34.61	-32.78
3.5	-42.85	-34.52	-34.02
4.0	-47.00	-34.83	-35.50
4.5	-48.71	-34.71	-36.71
5.0	-45.21	-34.54	-37.87

FREQ. PUSHING (MHz/V)
0.06
0.90
0.58
0.19
0.38
1.09
0.83
0.19
-0.13
-0.13
0.00

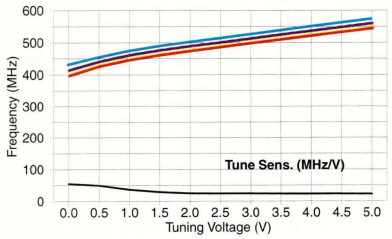
Frequency Pushing
(Supply Voltage 12V)



JTOS-765P

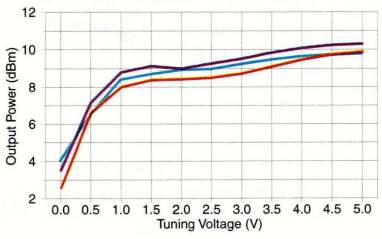
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

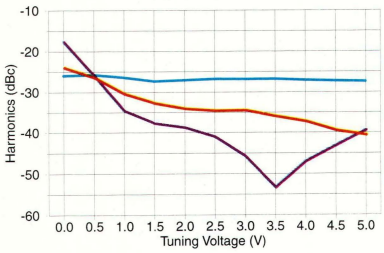


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	54.63	427.70	416.18	407.58	4.07	3.55	2.63
0.5	49.27	449.76	442.16	436.07	6.54	7.19	6.64
1.0	36.64	469.81	462.17	455.87	8.44	8.85	8.03
1.5	28.99	485.44	477.47	470.87	8.74	9.18	8.42
2.0	25.11	498.69	490.47	483.76	8.96	9.04	8.46
2.5	24.28	510.52	502.62	496.03	9.01	9.30	8.54
3.0	24.29	522.70	514.74	508.14	9.28	9.55	8.77
3.5	23.93	535.01	526.77	520.09	9.50	9.88	9.14
4.0	23.43	547.10	538.57	531.78	9.68	10.11	9.51
4.5	22.81	558.87	550.08	543.16	9.76	10.27	9.77
5.0	22.46	570.45	561.39	554.32	9.81	10.33	9.90

Power Output



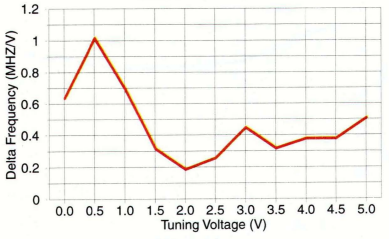
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-25.87	-17.54	-23.87
0.5	-25.69	-25.85	-26.35
1.0	-26.35	-34.51	-30.35
1.5	-27.29	-37.62	-32.62
2.0	-27.00	-38.67	-34.00
2.5	-26.71	-40.88	-34.54
3.0	-26.75	-45.59	-34.42
3.5	-26.71	-53.21	-35.88
4.0	-27.00	-46.83	-37.17
4.5	-27.22	-43.05	-39.39
5.0	-27.34	-39.34	-40.51

FREQ. PUSHING (MHz/V)
0.64
1.02
0.70
0.32
0.19
0.26
0.45
0.32
0.38
0.38
0.51

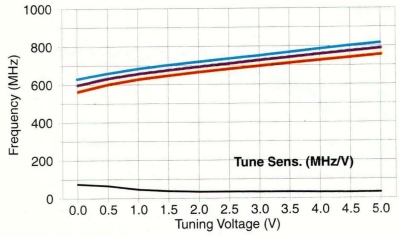
Frequency Pushing (Supply Voltage 12V)



JTOS-1025P

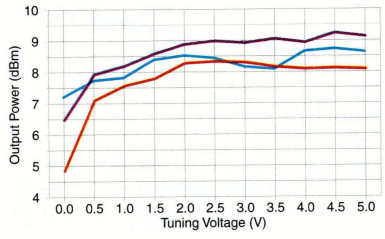
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

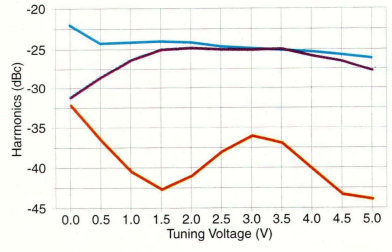


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	74.25	618.42	600.96	587.81	7.23	6.49	4.87
0.5	64.32	648.48	635.61	626.06	7.75	7.94	7.12
1.0	45.46	672.76	660.32	651.44	7.84	8.21	7.59
1.5	37.02	691.93	679.74	671.51	8.41	8.61	7.81
2.0	33.63	708.39	696.92	689.26	8.55	8.91	8.30
2.5	33.85	723.86	713.86	706.14	8.46	9.01	8.36
3.0	33.14	739.79	730.49	721.74	8.18	8.95	8.33
3.5	32.01	756.87	746.67	736.54	8.10	9.08	8.19
4.0	30.49	774.28	762.14	750.97	8.68	8.96	8.12
4.5	29.59	790.17	777.03	765.28	8.75	9.26	8.14
5.0	29.72	805.25	791.89	779.85	8.65	9.15	8.10

Power Output



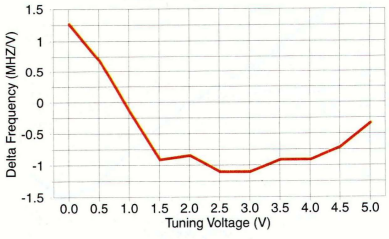
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-21.96	-31.12	-32.12
0.5	-24.17	-28.51	-36.51
1.0	-24.05	-26.22	-40.38
1.5	-23.94	-24.94	-42.60
2.0	-24.06	-24.73	-40.89
2.5	-24.58	-24.92	-37.92
3.0	-24.79	-24.96	-35.96
3.5	-25.00	-24.83	-36.83
4.0	-25.21	-25.71	-40.05
4.5	-25.59	-26.42	-43.25
5.0	-26.02	-27.68	-43.85

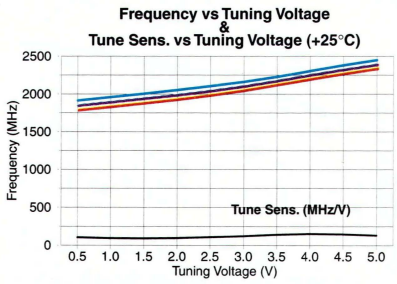
FREQ. PUSHING (MHz/V)
1.28
0.70
-0.13
-0.90
-0.83
-1.09
-1.09
-0.90
-0.90
-0.70
-0.32

Frequency Pushing (Supply Voltage 12V)

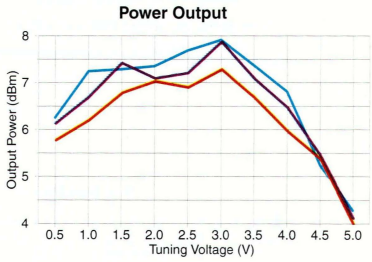


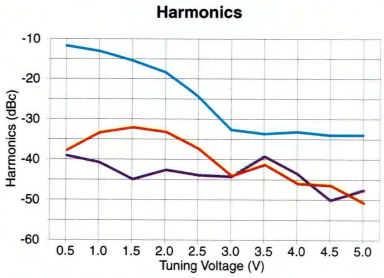
JTOS-2200PA

5V Tuning For PLL ICs- spec pg. 82



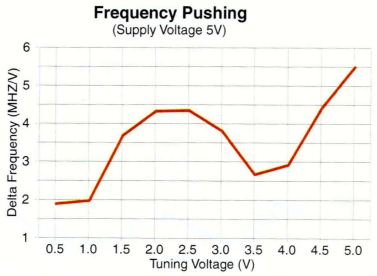
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.5	104.11	1882.25	1850.53	1820.54	6.26	6.14	5.78
1.0	93.59	1930.48	1897.32	1868.66	7.25	6.71	6.21
1.5	90.32	1975.00	1942.48	1915.50	7.29	7.43	6.79
2.0	95.76	2021.95	1990.36	1964.97	7.36	7.10	7.04
2.5	107.87	2073.74	2044.30	2020.54	7.69	7.22	6.91
3.0	121.69	2131.47	2105.14	2084.32	7.92	7.88	7.29
3.5	140.55	2196.59	2175.42	2157.95	7.38	7.10	6.69
4.0	153.61	2273.31	2252.22	2233.46	6.82	6.48	5.97
4.5	146.18	2349.59	2325.31	2304.31	5.25	5.46	5.38
5.0	133.55	2418.87	2392.09	2369.42	4.29	4.13	4.00





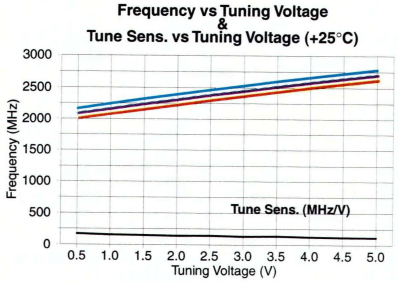
V TUNE	HARMONICS (dBc) F2	F3	F4
5.00	-11.67	-39.00	-37.67
1.00	-13.00	-40.66	-33.33
1.50	-15.34	-44.84	-32.00
2.00	-18.33	-42.50	-33.16
2.50	-24.34	-43.84	-37.34
3.00	-32.66	-44.16	-44.00
3.50	-33.67	-39.17	-41.17
4.00	-33.17	-43.50	-45.84
4.50	-34.00	-50.00	-46.33
5.00	-34.00	-47.50	-50.67

FREQ. PUSHING (MHz/V)
1.91
1.99
3.69
4.34
4.36
3.82
2.68
2.93
4.42
5.50

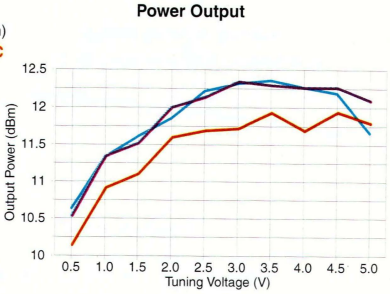


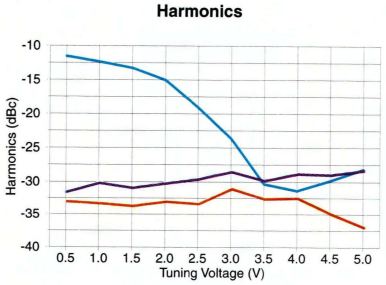
JTOS-3000P

5V Tuning For PLL ICs- spec pg. 82



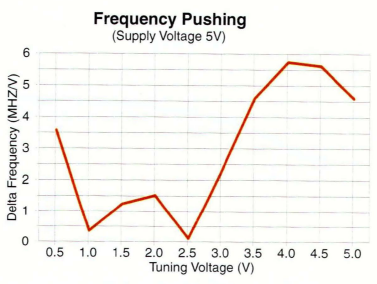
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.5	169.56	2116.65	2092.43	2071.53	10.64	10.54	10.15
1.0	155.58	2195.29	2169.49	2148.48	11.34	11.35	10.92
1.5	149.69	2270.64	2245.86	2223.70	11.62	11.53	11.11
2.0	139.47	2342.50	2315.57	2293.39	11.86	12.01	11.61
2.5	144.29	2413.01	2387.44	2364.81	12.22	12.14	11.70
3.0	129.94	2479.91	2453.47	2434.20	12.32	12.35	11.73
3.5	135.93	2548.18	2521.73	2501.82	12.36	12.30	11.94
4.0	124.26	2612.02	2587.12	2568.68	12.27	12.27	11.70
4.5	120.22	2674.56	2648.09	2628.71	12.19	12.27	11.95
5.0	116.49	2732.38	2706.89	2686.01	11.67	12.10	11.80





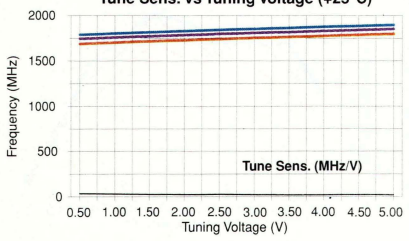
V TUNE	HARMONICS (dBc) F2	F3	F4
0.5	-11.47	-31.47	-32.97
1.0	-12.27	-30.11	-33.27
1.5	-13.17	-30.83	-33.67
2.0	-14.99	-30.15	-32.99
2.5	-19.00	-29.50	-33.33
3.0	-23.60	-28.43	-30.93
3.5	-30.19	-29.69	-32.52
4.0	-31.22	-28.72	-32.38
4.5	-29.69	-28.85	-34.85
5.0	-28.05	-28.21	-36.88

FREQ. PUSHING (MHz/V)
3.59
0.38
1.27
1.54
0.13
2.30
4.61
5.77
5.64
4.62

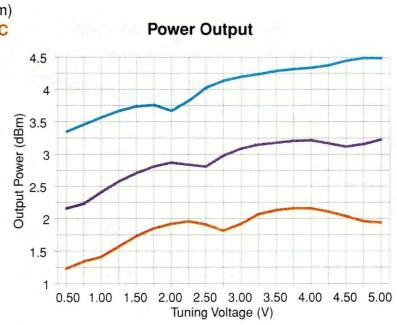


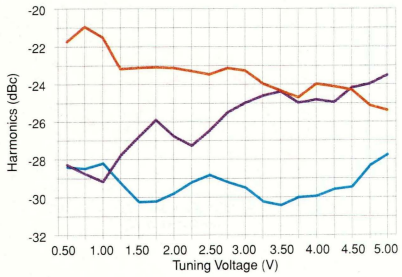
MOS-1826PV

5V Tuning For PLL ICs- spec pg. 82



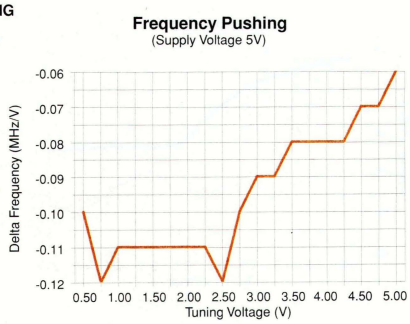
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	36.17	1749.75	1737.92	1731.10	3.34	2.15	1.22
0.75	32.98	1757.76	1746.17	1739.27	3.45	2.22	1.33
1.00	30.44	1765.12	1753.78	1746.90	3.56	2.40	1.40
1.25	27.68	1772.07	1760.70	1754.08	3.66	2.57	1.56
1.50	26.25	1778.66	1767.26	1760.70	3.73	2.70	1.72
1.75	25.44	1785.01	1773.62	1767.03	3.75	2.80	1.84
2.00	24.30	1791.56	1779.69	1773.23	3.66	2.86	1.91
2.25	24.02	1798.31	1785.70	1779.17	3.82	2.83	1.95
2.50	25.22	1804.06	1792.01	1785.01	4.02	2.80	1.90
2.75	24.04	1809.62	1798.01	1791.06	4.13	2.97	1.81
3.00	21.96	1815.12	1803.50	1797.22	4.19	3.08	1.91
3.25	21.57	1820.60	1808.90	1802.74	4.23	3.14	2.06
3.50	21.43	1826.06	1814.25	1808.08	4.28	3.17	2.12
3.75	21.38	1831.52	1819.60	1813.40	4.31	3.20	2.15
4.00	21.36	1837.03	1824.94	1818.73	4.33	3.21	2.15
4.25	21.54	1842.55	1830.32	1824.11	4.37	3.16	2.10
4.50	22.00	1847.86	1835.82	1829.52	4.44	3.11	2.03
4.75	22.28	1853.07	1841.39	1835.01	4.48	3.15	1.95
5.00	21.24	1858.27	1846.70	1840.64	4.48	3.22	1.93





V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-28.44	-28.32	-21.77
0.75	-28.51	-28.79	-20.98
1.00	-28.23	-29.20	-21.54
1.25	-29.27	-27.83	-23.21
1.50	-30.27	-26.85	-23.14
1.75	-30.23	-25.93	-23.11
2.00	-29.82	-26.81	-23.16
2.25	-29.23	-27.32	-23.32
2.50	-28.85	-26.52	-23.51
2.75	-29.23	-25.53	-23.17
3.00	-29.53	-25.02	-23.31
3.25	-30.26	-24.64	-23.99
3.50	-30.46	-24.40	-24.37
3.75	-30.04	-25.01	-24.73
4.00	-29.98	-24.85	-24.01
4.25	-29.61	-24.99	-24.14
4.50	-29.49	-24.20	-24.32
4.75	-28.38	-24.01	-25.16
5.00	-27.79	-23.55	-25.43

V TUNE	FREQ. PUSHING (MHz/V)
0.50	-0.10
0.75	-0.12
1.00	-0.11
1.25	-0.11
1.50	-0.11
1.75	-0.11
2.00	-0.11
2.25	-0.11
2.50	-0.12
2.75	-0.10
3.00	-0.09
3.25	-0.09
3.50	-0.08
3.75	-0.08
4.00	-0.08
4.25	-0.08
4.50	-0.07
4.75	-0.07
5.00	-0.06



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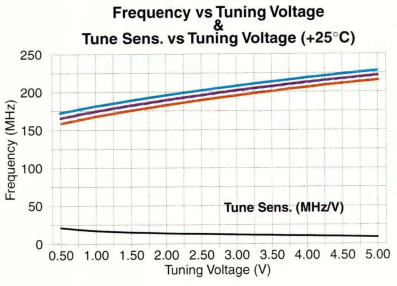
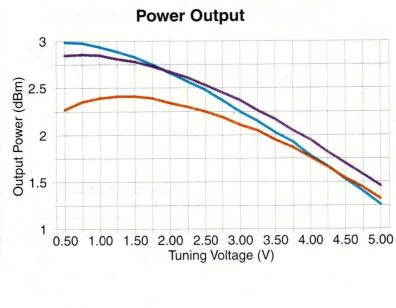
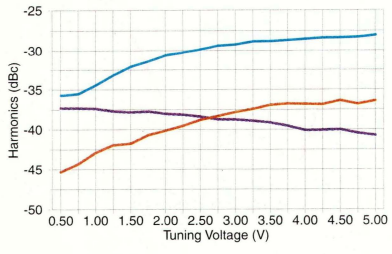
5V Tuning For PLL ICs- spec pg. 82



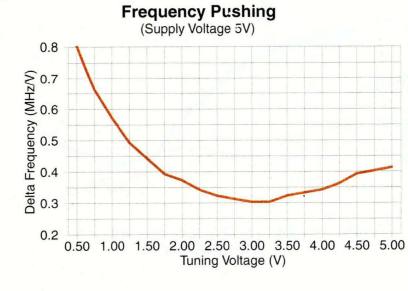
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	21.07	167.42	164.34	162.20	2.98	2.84	2.26
0.75	18.68	171.96	169.01	166.95	2.97	2.85	2.34
1.00	17.05	176.12	173.27	171.26	2.93	2.84	2.38
1.25	15.96	180.03	177.26	175.28	2.88	2.80	2.40
1.50	15.07	183.71	181.03	179.07	2.82	2.77	2.40
1.75	14.31	187.22	184.61	182.67	2.74	2.72	2.38
2.00	13.75	190.59	188.04	186.13	2.65	2.66	2.33
2.25	13.21	193.82	191.34	189.45	2.56	2.60	2.29
2.50	12.80	196.95	194.54	192.67	2.47	2.52	2.24
2.75	12.36	199.98	197.63	195.79	2.36	2.44	2.18
3.00	11.95	202.91	200.62	198.80	2.24	2.36	2.10
3.25	11.53	205.75	203.50	201.72	2.14	2.25	2.04
3.50	11.11	208.50	206.28	204.53	2.02	2.16	1.94
3.75	10.69	211.15	208.95	207.24	1.92	2.04	1.86
4.00	10.29	213.71	211.53	209.85	1.77	1.94	1.75
4.25	9.89	216.17	214.00	212.35	1.66	1.81	1.65
4.50	9.46	218.54	216.36	214.75	1.52	1.69	1.53
4.75	9.04	220.79	218.62	217.03	1.39	1.57	1.43
5.00	8.60	222.95	220.77	219.20	1.25	1.45	1.31





V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-35.81	-37.41	-45.45
0.75	-35.63	-37.45	-44.44
1.00	-34.53	-37.49	-43.03
1.25	-33.27	-37.83	-42.08
1.50	-32.17	-37.94	-41.89
1.75	-31.47	-37.85	-40.81
2.00	-30.68	-38.13	-40.26
2.25	-30.34	-38.26	-39.66
2.50	-29.93	-38.51	-38.91
2.75	-29.45	-38.86	-38.44
3.00	-29.30	-38.88	-37.95
3.25	-28.92	-39.05	-37.57
3.50	-28.89	-39.26	-37.06
3.75	-28.74	-39.67	-36.89
4.00	-28.59	-40.22	-36.96
4.25	-28.45	-40.19	-37.00
4.50	-28.44	-40.12	-36.50
4.75	-28.38	-40.58	-36.93
5.00	-28.12	-40.84	-36.52

V TUNE	FREQ. PUSHING (MHz/V)
0.50	0.80
0.75	0.66
1.00	0.57
1.25	0.49
1.50	0.44
1.75	0.39
2.00	0.37
2.25	0.34
2.50	0.32
2.75	0.31
3.00	0.30
3.25	0.30
3.50	0.32
3.75	0.33
4.00	0.34
4.25	0.36
4.50	0.39
4.75	0.40
5.00	0.41



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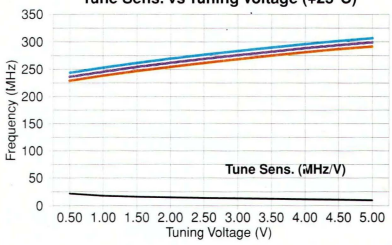
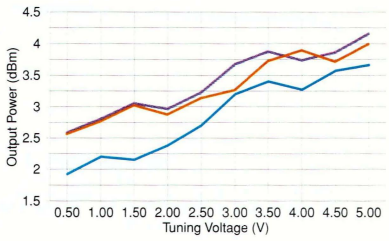
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

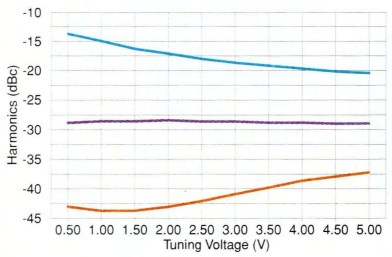


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	21.97	238.58	235.41	232.77	1.92	2.58	2.56
1.00	18.29	248.02	244.92	242.29	2.20	2.80	2.76
1.50	16.37	256.43	253.32	250.66	2.15	3.05	3.02
2.00	15.19	264.18	261.05	258.35	2.38	2.96	2.87
2.50	14.32	271.45	268.29	265.57	2.70	3.22	3.13
3.00	13.55	278.31	275.15	272.41	3.20	3.67	3.26
3.50	12.75	284.78	281.64	278.86	3.40	3.87	3.72
4.00	11.87	290.82	287.69	284.88	3.27	3.73	3.89
4.50	10.91	296.39	293.27	290.45	3.57	3.86	3.71
5.00	9.93	301.45	298.36	295.53	3.66	4.15	3.99

Power Output



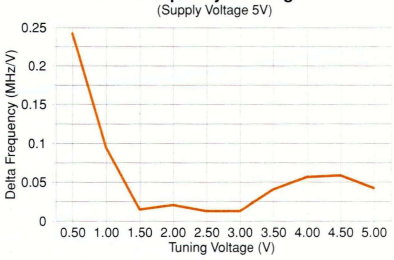
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-13.78	-28.94	-43.11
1.00	-15.00	-28.66	-43.83
1.50	-16.33	-28.67	-43.83
2.00	-17.18	-28.51	-43.18
2.50	-18.04	-28.70	-42.20
3.00	-18.71	-28.71	-41.04
3.50	-19.24	-28.91	-39.91
4.00	-19.74	-28.91	-38.74
4.50	-20.21	-29.04	-38.04
5.00	-20.51	-29.01	-37.35

FREQ. PUSHING (MHz/V)
0.24
0.09
0.01
0.02
0.01
0.01
0.04
0.06
0.06
0.04

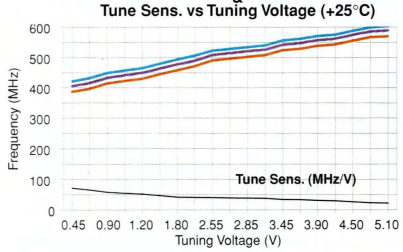
Frequency Pushing (Supply Voltage 5V)



ROS-550PV

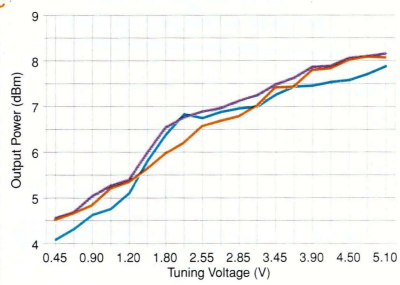
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

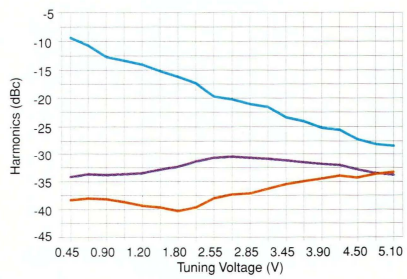


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.45	72.32	411.96	403.14	396.60	4.08	4.54	4.50
0.60	66.08	421.84	413.05	406.67	4.31	4.67	4.64
0.90	58.45	439.76	431.13	424.69	4.62	5.02	4.82
1.05	55.48	448.07	439.45	432.94	4.75	5.25	5.19
1.20	52.48	455.96	447.33	440.73	5.10	5.38	5.33
1.50	47.74	470.83	462.00	455.31	5.79	5.96	5.61
1.80	42.69	484.59	475.23	469.06	6.37	6.52	5.95
2.10	41.48	497.27	487.56	482.29	6.82	6.75	6.18
2.55	41.03	513.32	506.26	501.08	6.74	6.87	6.55
2.70	39.88	519.27	512.24	507.04	6.87	6.95	6.67
2.85	38.97	525.09	518.09	512.85	6.95	7.11	6.77
3.00	37.98	530.76	523.78	518.51	6.99	7.23	7.00
3.45	34.69	546.80	539.92	534.52	7.25	7.47	7.40
3.60	33.88	551.86	545.00	539.56	7.43	7.61	7.42
3.90	31.45	561.42	554.61	549.06	7.45	7.85	7.78
4.05	30.37	565.95	559.16	553.56	7.53	7.87	7.82
4.50	26.96	578.58	571.83	565.99	7.57	8.04	8.00
4.95	23.46	589.72	582.94	576.79	7.70	8.08	8.07
5.10	22.50	593.12	586.31	580.04	7.87	8.14	8.05

Power Output



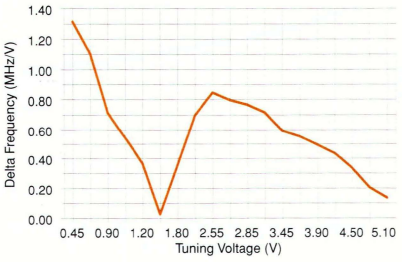
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.45	-9.50	-34.34	-38.50
0.60	-10.84	-33.84	-38.17
0.90	-12.83	-34.00	-38.33
1.05	-13.50	-33.84	-38.84
1.20	-14.17	-33.67	-39.50
1.50	-15.34	-33.00	-39.84
1.80	-16.33	-32.50	-40.50
2.10	-17.50	-31.50	-39.83
2.55	-19.83	-30.83	-38.17
2.70	-20.33	-30.66	-37.50
2.85	-21.17	-30.84	-37.34
3.00	-21.67	-31.00	-36.50
3.45	-23.50	-31.33	-35.66
3.60	-24.17	-31.67	-35.17
3.90	-25.34	-32.00	-34.67
4.05	-25.66	-32.16	-34.16
4.50	-27.33	-33.00	-34.50
4.95	-28.17	-33.67	-33.84
5.10	-28.50	-34.00	-33.50

FREQ. PUSHING (MHz/V)
1.31
1.10
0.71
0.54
0.36
0.02
0.35
0.69
0.84
0.79
0.76
0.71
0.59
0.55
0.49
0.43
0.33
0.20
0.13

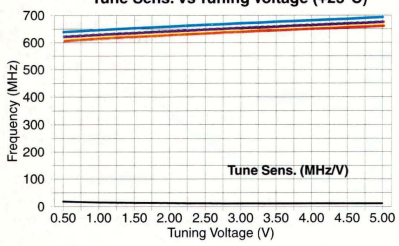
Frequency Pushing (Supply Voltage 5V)



ROS-660PV

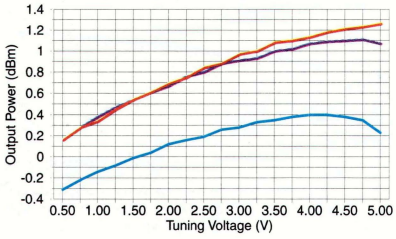
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

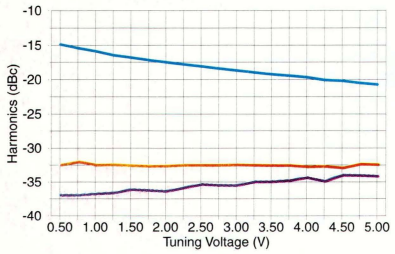


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	18.26	626.36	622.45	619.04	-0.31	0.16	0.16
0.75	16.33	630.28	626.53	623.25	-0.22	0.28	0.28
1.00	14.94	633.91	630.26	627.06	-0.14	0.38	0.34
1.25	14.05	637.35	633.78	630.63	-0.08	0.47	0.45
1.50	13.28	640.62	637.10	633.98	-0.01	0.54	0.54
1.75	12.70	643.76	640.27	637.18	0.04	0.61	0.61
2.00	12.29	646.81	643.34	640.26	0.12	0.67	0.69
2.25	11.87	649.76	646.31	643.24	0.16	0.76	0.75
2.50	11.71	652.67	649.24	646.16	0.19	0.80	0.84
2.75	11.42	655.53	652.10	649.02	0.26	0.88	0.88
3.00	11.30	658.35	654.92	651.84	0.28	0.91	0.97
3.25	11.16	661.13	657.71	654.62	0.33	0.93	1.00
3.50	11.03	663.89	660.47	657.38	0.35	1.00	1.08
3.75	10.97	666.63	663.21	660.11	0.38	1.02	1.10
4.00	10.94	669.36	665.95	662.84	0.40	1.07	1.13
4.25	10.93	672.11	668.68	665.56	0.40	1.09	1.18
4.50	10.94	674.86	671.41	668.29	0.38	1.10	1.21
4.75	10.96	677.66	674.15	671.01	0.35	1.11	1.23
5.00	11.10	680.57	676.93	673.75	0.23	1.07	1.26

Power Output



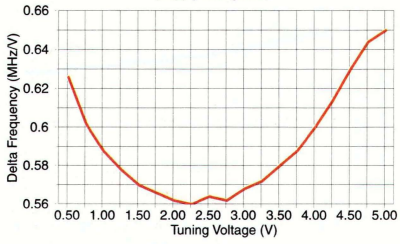
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-14.87	-36.95	-32.42
0.75	-15.40	-36.92	-31.99
1.00	-15.89	-36.72	-32.46
1.25	-16.46	-36.60	-32.40
1.50	-16.79	-36.11	-32.55
1.75	-17.16	-36.24	-32.64
2.00	-17.47	-36.35	-32.61
2.25	-17.79	-35.86	-32.48
2.50	-18.10	-35.34	-32.50
2.75	-18.40	-35.48	-32.51
3.00	-18.68	-35.52	-32.44
3.25	-18.95	-34.96	-32.48
3.50	-19.24	-34.93	-32.52
3.75	-19.44	-34.77	-32.52
4.00	-19.66	-34.32	-32.72
4.25	-20.06	-34.87	-32.66
4.50	-20.18	-34.00	-32.90
4.75	-20.50	-34.02	-32.34
5.00	-20.71	-34.11	-32.40

V TUNE	FREQ. PUSHING (MHz/V)
0.50	0.63
0.75	0.60
1.00	0.59
1.25	0.58
1.50	0.57
1.75	0.57
2.00	0.56
2.25	0.56
2.50	0.56
2.75	0.56
3.00	0.57
3.25	0.57
3.50	0.58
3.75	0.59
4.00	0.60
4.25	0.61
4.50	0.63
4.75	0.64
5.00	0.65

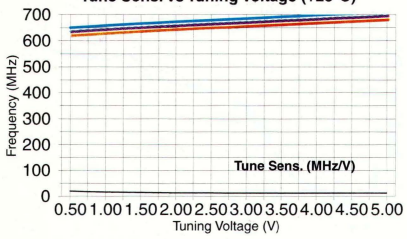
Frequency Pushing
(Supply Voltage 5V)



ROS-675PV

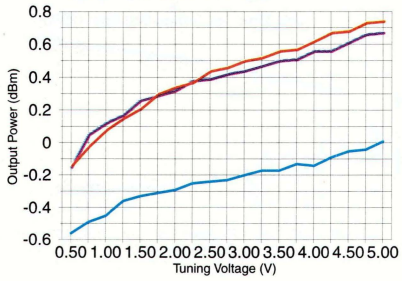
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

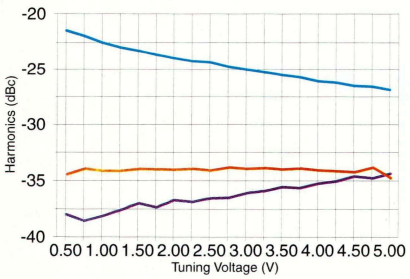


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	19.66	640.48	636.17	631.77	-0.56	-0.15	-0.14
0.75	17.62	644.72	640.57	636.32	-0.49	0.05	-0.02
1.00	16.11	648.68	644.60	640.44	-0.45	0.12	0.08
1.25	15.21	652.41	648.40	644.29	-0.36	0.17	0.15
1.50	14.40	655.94	652.00	647.94	-0.33	0.26	0.21
1.75	13.77	659.33	655.45	651.40	-0.31	0.29	0.30
2.00	13.35	662.65	658.78	654.75	-0.29	0.32	0.34
2.25	12.94	665.87	662.02	657.99	-0.25	0.38	0.37
2.50	12.77	669.06	665.21	661.18	-0.24	0.39	0.44
2.75	12.51	672.20	668.34	664.31	-0.23	0.42	0.46
3.00	12.39	675.29	671.44	667.39	-0.20	0.44	0.50
3.25	12.22	678.35	674.49	670.44	-0.17	0.47	0.52
3.50	12.17	681.39	677.53	673.47	-0.17	0.50	0.56
3.75	12.15	684.44	680.57	676.49	-0.13	0.51	0.57
4.00	12.14	687.48	683.60	679.51	-0.14	0.56	0.62
4.25	12.19	690.56	686.65	682.53	-0.09	0.56	0.67
4.50	12.17	693.64	689.69	685.56	-0.05	0.61	0.68
4.75	12.29	696.72	692.77	688.61	-0.04	0.66	0.73
5.00	12.29	699.81	695.84	691.67	0.01	0.67	0.74

Power Output



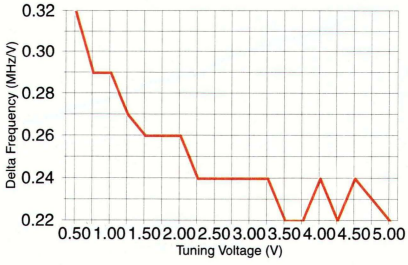
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-21.40	-37.92	-34.38
0.75	-21.87	-38.49	-33.89
1.00	-22.46	-38.05	-34.08
1.25	-22.89	-37.55	-34.08
1.50	-23.20	-36.92	-33.90
1.75	-23.59	-37.29	-33.95
2.00	-23.91	-36.65	-33.97
2.25	-24.20	-36.80	-33.88
2.50	-24.30	-36.49	-34.03
2.75	-24.72	-36.44	-33.77
3.00	-24.98	-36.03	-33.89
3.25	-25.21	-35.84	-33.81
3.50	-25.48	-35.49	-33.95
3.75	-25.68	-35.57	-33.85
4.00	-26.05	-35.18	-34.02
4.25	-26.18	-34.99	-34.10
4.50	-26.45	-34.56	-34.19
4.75	-26.53	-34.72	-33.76
5.00	-26.83	-34.32	-34.69

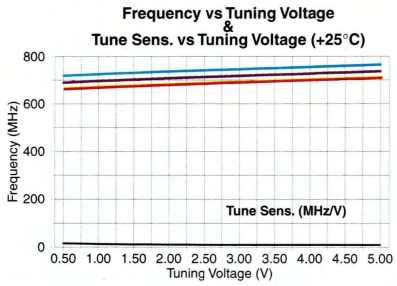
V TUNE	FREQ. PUSHING (MHz/V)
0.50	0.32
0.75	0.29
1.00	0.29
1.25	0.27
1.50	0.26
1.75	0.26
2.00	0.26
2.25	0.24
2.50	0.24
2.75	0.24
3.00	0.24
3.25	0.24
3.50	0.22
3.75	0.22
4.00	0.24
4.25	0.22
4.50	0.24
4.75	0.23
5.00	0.22

Frequency Pushing
(Supply Voltage 5V)

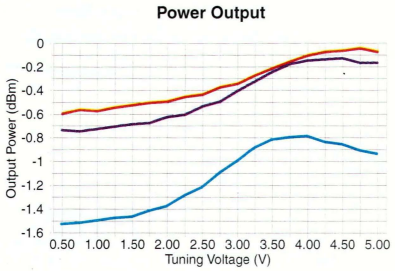


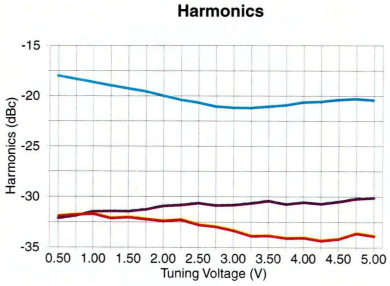
ROS-725PV

5V Tuning For PLL ICs- spec pg. 82

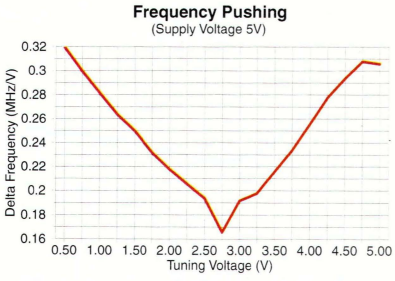


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	15.72	696.16	692.61	689.31	-1.52	-0.73	-0.59
0.75	14.18	699.60	696.15	692.95	-1.51	-0.74	-0.56
1.00	13.01	702.78	699.41	696.25	-1.49	-0.72	-0.57
1.25	12.30	705.81	702.48	699.35	-1.47	-0.70	-0.54
1.50	11.67	708.70	705.40	702.29	-1.46	-0.68	-0.52
1.75	11.17	711.46	708.19	705.09	-1.41	-0.67	-0.50
2.00	10.85	714.14	710.90	707.79	-1.37	-0.62	-0.49
2.25	10.48	716.72	713.52	710.42	-1.28	-0.60	-0.45
2.50	10.24	719.23	716.08	712.99	-1.21	-0.53	-0.43
2.75	9.95	721.63	718.57	715.50	-1.09	-0.49	-0.37
3.00	9.69	723.96	720.99	717.96	-0.99	-0.40	-0.34
3.25	9.40	726.22	723.34	720.35	-0.88	-0.32	-0.27
3.50	9.19	728.47	725.64	722.70	-0.81	-0.24	-0.21
3.75	9.08	730.74	727.91	725.01	-0.79	-0.17	-0.15
4.00	9.08	733.07	730.18	727.30	-0.78	-0.14	-0.10
4.25	9.23	735.46	732.49	729.59	-0.83	-0.13	-0.07
4.50	9.37	737.92	734.83	731.88	-0.85	-0.12	-0.06
4.75	9.62	740.42	737.23	734.23	-0.90	-0.16	-0.04
5.00	9.83	742.98	739.69	736.61	-0.93	-0.16	-0.07



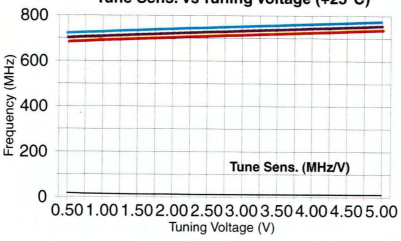


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-17.95	-32.05	-31.85	0.32
0.75	-18.28	-31.80	-31.72	0.30
1.00	-18.57	-31.41	-31.65	0.28
1.25	-18.90	-31.38	-32.06	0.26
1.50	-19.20	-31.40	-31.95	0.25
1.75	-19.49	-31.19	-32.15	0.23
2.00	-19.92	-30.85	-32.32	0.22
2.25	-20.32	-30.76	-32.21	0.21
2.50	-20.59	-30.57	-32.71	0.19
2.75	-20.97	-30.79	-32.90	0.17
3.00	-21.12	-30.76	-33.28	0.19
3.25	-21.13	-30.58	-33.82	0.20
3.50	-21.01	-30.35	-33.78	0.22
3.75	-20.87	-30.68	-34.02	0.23
4.00	-20.58	-30.50	-33.99	0.26
4.25	-20.53	-30.65	-34.27	0.28
4.50	-20.32	-30.43	-34.10	0.29
4.75	-20.25	-30.15	-33.55	0.31
5.00	-20.36	-30.06	-33.82	0.31

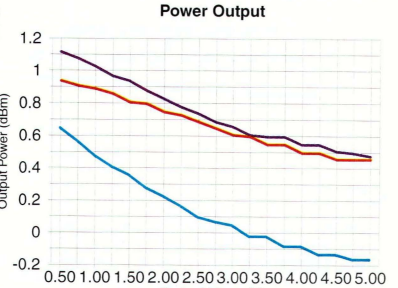


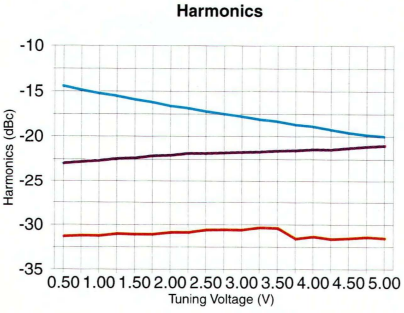
ROS-740PV

5V Tuning For PLL ICs- spec pg. 82

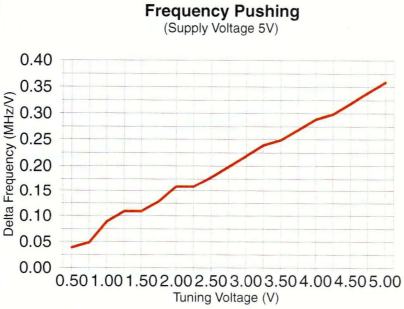


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	16.80	707.20	703.51	699.64	0.65	1.12	0.94
0.75	15.20	710.89	707.31	703.55	0.57	1.08	0.91
1.00	13.96	714.33	710.80	707.12	0.48	1.03	0.89
1.25	13.24	717.60	714.11	710.48	0.41	0.97	0.86
1.50	12.60	720.74	717.26	713.65	0.36	0.94	0.81
1.75	12.06	723.76	720.28	716.69	0.28	0.88	0.80
2.00	11.77	726.71	723.22	719.64	0.23	0.83	0.75
2.25	11.45	729.58	726.08	722.50	0.17	0.78	0.73
2.50	11.30	732.42	728.90	725.31	0.10	0.74	0.69
2.75	11.12	735.22	731.68	728.08	0.07	0.69	0.65
3.00	11.01	738.01	734.44	730.81	0.05	0.66	0.61
3.25	10.94	740.77	737.17	733.53	-0.02	0.61	0.60
3.50	10.92	743.53	739.90	736.23	-0.02	0.60	0.55
3.75	10.89	746.29	742.62	738.93	-0.08	0.60	0.55
4.00	10.92	749.05	745.35	741.63	-0.08	0.55	0.50
4.25	11.00	751.84	748.10	744.36	-0.13	0.55	0.50
4.50	11.03	754.63	750.86	747.09	-0.13	0.51	0.46
4.75	11.11	757.44	753.64	749.84	-0.16	0.50	0.46
5.00	11.21	760.29	756.44	752.61	-0.16	0.48	0.46





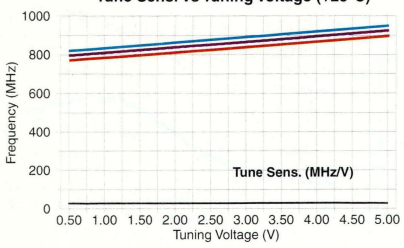
V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-14.35	-22.83	-31.18	0.04
0.75	-14.78	-22.67	-31.12	0.05
1.00	-15.16	-22.53	-31.14	0.09
1.25	-15.42	-22.33	-30.93	0.11
1.50	-15.82	-22.26	-30.98	0.11
1.75	-16.11	-22.03	-30.99	0.13
2.00	-16.52	-21.95	-30.77	0.16
2.25	-16.77	-21.75	-30.76	0.16
2.50	-17.10	-21.76	-30.50	0.18
2.75	-17.40	-21.68	-30.46	0.20
3.00	-17.67	-21.63	-30.47	0.22
3.25	-18.00	-21.57	-30.23	0.24
3.50	-18.20	-21.48	-30.29	0.25
3.75	-18.58	-21.42	-31.46	0.27
4.00	-18.77	-21.33	-31.24	0.29
4.25	-19.13	-21.35	-31.52	0.30
4.50	-19.48	-21.17	-31.43	0.32
4.75	-19.73	-21.02	-31.30	0.34
5.00	-19.91	-20.92	-31.43	0.36



ROS-900PV

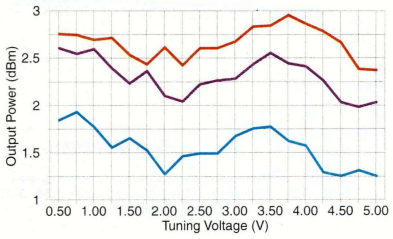
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

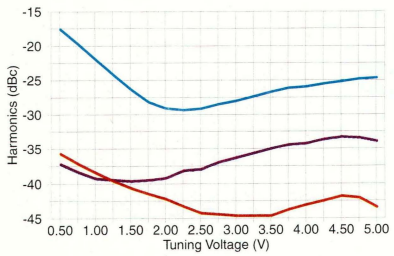


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	27.93	798.86	794.32	790.13	1.84	2.60	2.75
0.75	27.55	805.79	801.21	797.21	1.93	2.54	2.74
1.00	27.86	812.84	808.17	804.22	1.77	2.59	2.69
1.25	28.19	819.97	815.22	811.18	1.55	2.39	2.71
1.50	28.16	827.08	822.26	818.09	1.65	2.23	2.53
1.75	28.13	834.19	829.29	824.98	1.52	2.36	2.43
2.00	28.17	841.32	836.33	831.87	1.27	2.10	2.61
2.25	28.16	848.46	843.37	838.73	1.46	2.04	2.42
2.50	28.35	855.68	850.46	845.67	1.49	2.22	2.60
2.75	28.39	862.87	857.56	852.63	1.49	2.26	2.60
3.00	28.70	870.11	864.73	859.62	1.67	2.28	2.67
3.25	28.76	877.40	871.92	866.67	1.75	2.43	2.83
3.50	28.84	884.69	879.13	873.75	1.77	2.55	2.84
3.75	28.85	891.99	886.34	880.84	1.62	2.44	2.95
4.00	28.90	899.27	893.57	887.92	1.57	2.41	2.86
4.25	28.76	906.53	900.76	894.98	1.29	2.26	2.78
4.50	28.47	913.70	907.88	901.99	1.25	2.03	2.66
5.00	27.44	927.57	921.76	915.71	1.31	1.98	2.38
					1.25	2.03	2.37

Power Output

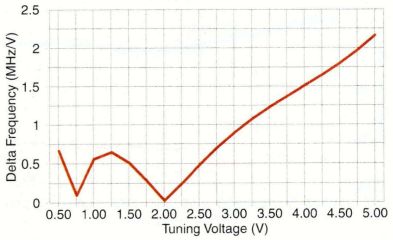


Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-17.67	-37.34	-35.84	0.65
0.75	-19.80	-38.46	-37.30	0.09
1.00	-22.03	-39.36	-38.53	0.55
1.25	-24.22	-39.56	-39.72	0.64
1.50	-26.40	-39.73	-40.73	0.50
1.75	-28.26	-39.59	-41.59	0.27
2.00	-29.14	-39.30	-42.30	0.02
2.25	-29.41	-38.24	-43.41	0.24
2.50	-29.22	-38.06	-44.39	0.47
2.75	-28.56	-37.06	-44.56	0.69
3.00	-28.08	-36.41	-44.74	0.89
3.25	-27.41	-35.74	-44.74	1.07
3.50	-26.74	-35.08	-44.74	1.22
3.75	-26.20	-34.54	-43.87	1.36
4.00	-26.01	-34.34	-43.17	1.51
4.25	-25.56	-33.73	-42.56	1.64
4.50	-25.23	-33.40	-41.90	1.79
4.75	-24.85	-33.51	-42.18	1.96
5.00	-24.70	-34.03	-43.53	2.16

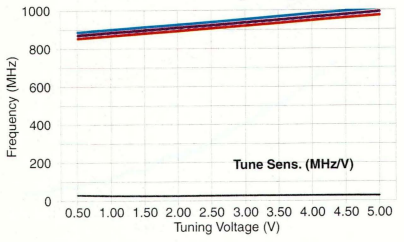
Frequency Pushing (Supply Voltage 4.5V)



ROS-960PV

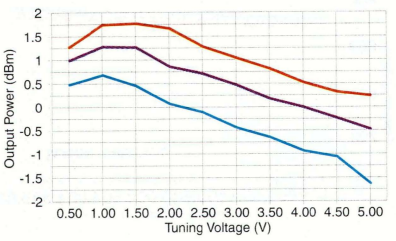
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

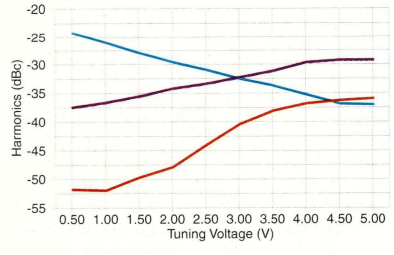


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	28.98	871.76	867.13	863.73	0.47	0.97	1.25
1.00	26.18	884.93	880.22	876.80	0.67	1.26	1.72
1.50	25.56	897.89	893.00	889.45	0.44	1.25	1.75
2.00	25.81	911.01	905.90	902.20	0.06	0.84	1.65
2.50	26.21	924.34	919.01	915.12	-0.12	0.69	1.26
3.00	27.04	938.09	932.53	928.44	-0.45	0.45	1.02
3.50	27.52	952.05	946.29	942.02	-0.66	0.16	0.79
4.00	27.75	966.07	960.17	955.74	-0.95	-0.02	0.50
4.50	27.49	979.98	973.91	969.27	-1.07	-0.25	0.30
5.00	26.90	993.64	987.36	982.54	-1.64	-0.50	0.22

Power Output

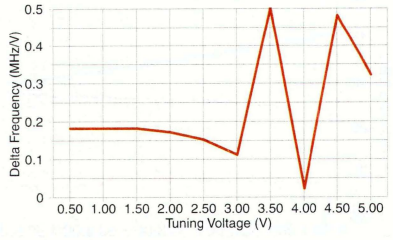


Harmonics



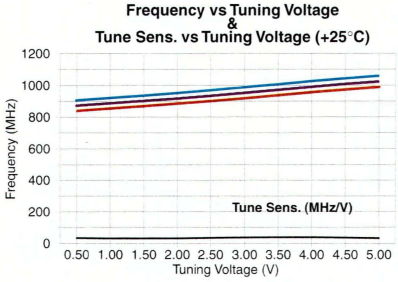
V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-24.28	-37.62	-51.95	0.18
1.00	-26.12	-36.79	-52.12	0.18
1.50	-28.01	-35.68	-49.85	0.18
2.00	-29.71	-34.37	-48.04	0.17
2.50	-31.03	-33.53	-44.19	0.15
3.00	-32.55	-32.39	-40.55	0.11
3.50	-33.78	-31.28	-38.28	0.50
4.00	-35.33	-29.83	-37.00	0.02
4.50	-36.95	-29.45	-36.45	0.48
5.00	-37.12	-29.45	-36.12	0.32

Frequency Pushing (Supply Voltage 5V)

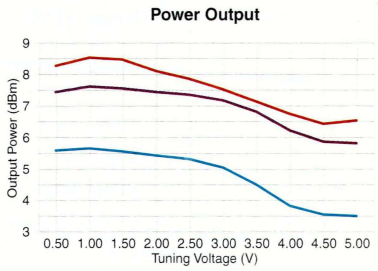


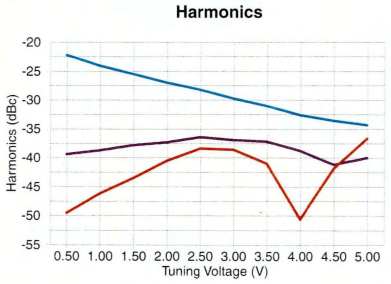
ROS-1000PV

5V Tuning For PLL ICs- spec pg. 82



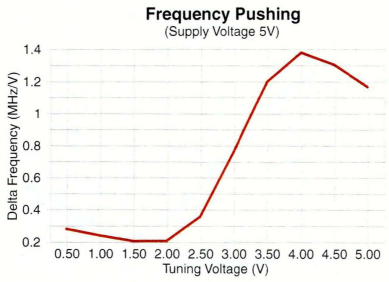
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	33.38	883.62	877.27	871.87	5.62	7.48	8.31
1.00	29.63	898.34	892.08	886.86	5.69	7.65	8.57
1.50	29.41	913.14	906.78	901.47	5.59	7.59	8.51
2.00	31.11	928.99	922.34	916.79	5.46	7.48	8.14
2.50	33.50	946.22	939.08	933.18	5.35	7.39	7.89
3.00	36.13	964.78	957.15	950.93	5.08	7.21	7.56
3.50	37.49	983.97	975.89	969.35	4.53	6.85	7.17
4.00	36.99	1002.83	994.39	987.52	3.86	6.25	6.78
4.50	34.57	1020.29	1011.67	1004.57	3.58	5.90	6.47
5.00	31.42	1036.01	1027.38	1020.23	3.53	5.85	6.57





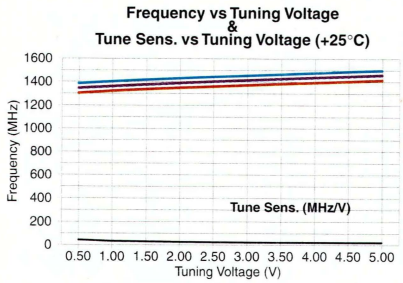
V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-22.09	-39.25	-49.42
1.00	-23.91	-38.58	-46.08
1.50	-25.35	-37.69	-43.35
2.00	-26.87	-37.20	-40.37
2.50	-28.10	-36.27	-38.27
3.00	-29.62	-36.79	-38.45
3.50	-30.89	-37.05	-40.89
4.00	-32.47	-38.64	-50.47
4.50	-33.42	-41.08	-41.75
5.00	-34.18	-39.85	-36.51

FREQ. PUSHING (MHz/V)
0.29
0.25
0.21
0.21
0.36
0.77
1.21
1.39
1.31
1.17

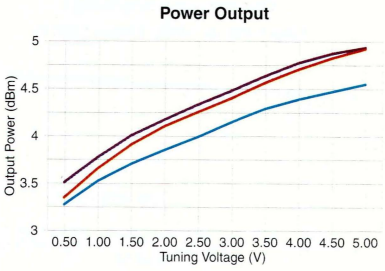


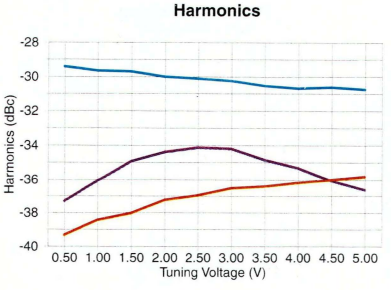
ROS-1435PV

5V Tuning For PLL ICs- spec pg. 82



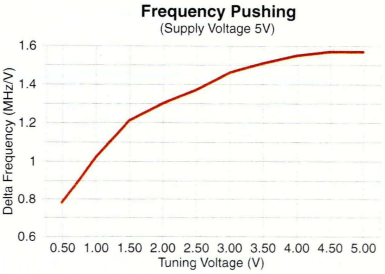
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	42.22	1367.29	1354.58	1349.90	3.28	3.51	3.35
1.00	33.44	1383.81	1371.29	1366.43	3.53	3.78	3.66
1.50	29.28	1398.46	1385.93	1380.79	3.71	4.01	3.91
2.00	26.65	1411.91	1399.26	1393.87	3.86	4.18	4.11
2.50	24.97	1424.55	1411.74	1406.08	4.00	4.34	4.26
3.00	23.83	1436.65	1423.66	1417.71	4.16	4.49	4.41
3.50	22.97	1448.37	1435.14	1428.89	4.30	4.64	4.57
4.00	22.40	1459.82	1446.34	1439.78	4.40	4.78	4.71
4.50	22.07	1471.14	1457.38	1450.46	4.48	4.88	4.83
5.00	21.75	1482.33	1468.25	1460.97	4.56	4.94	4.93





V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-29.40	-37.32	-39.33
1.00	-29.64	-36.08	-38.44
1.50	-29.69	-34.94	-38.04
2.00	-30.00	-34.40	-37.25
2.50	-30.09	-34.13	-36.96
3.00	-30.23	-34.20	-36.53
3.50	-30.52	-34.84	-36.42
4.00	-30.67	-35.32	-36.19
4.50	-30.60	-36.06	-36.00
5.00	-30.73	-36.62	-35.82

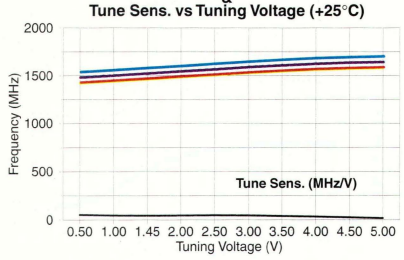
FREQ. PUSHING (MHz/V)
0.78
1.02
1.21
1.30
1.37
1.46
1.51
1.55
1.57
1.57



ROS-1600PV

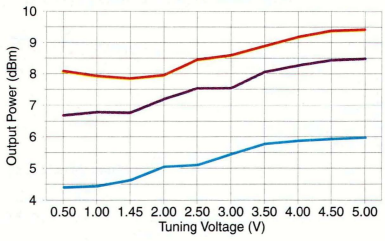
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

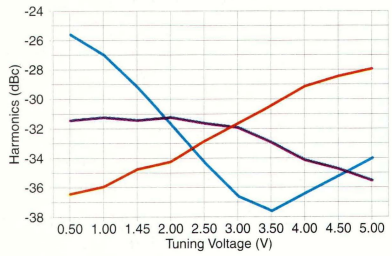


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	49.70	1481.38	1470.62	1460.02	4.36	6.65	8.06
1.00	44.10	1503.13	1492.65	1481.95	4.40	6.75	7.91
1.45	42.60	1524.32	1513.92	1503.01	4.59	6.73	7.83
2.00	43.90	1545.66	1535.90	1524.43	5.01	7.16	7.93
2.50	45.20	1569.15	1558.52	1546.12	5.07	7.50	8.43
3.00	43.60	1592.01	1580.33	1567.14	5.42	7.51	8.57
3.50	39.30	1612.34	1600.00	1586.13	5.74	8.03	8.86
4.00	32.10	1628.52	1616.05	1601.77	5.84	8.24	9.16
4.50	23.90	1639.88	1627.97	1613.35	5.90	8.41	9.36
5.00	16.20	1646.98	1636.06	1621.15	5.94	8.45	9.40

Power Output



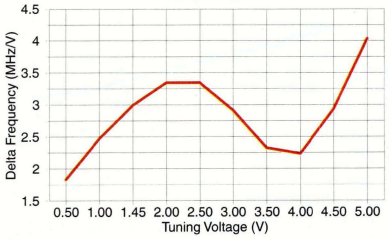
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-25.70	-31.50	-36.50
1.00	-27.10	-31.30	-36.00
1.45	-29.30	-31.50	-34.80
2.00	-31.80	-31.30	-34.30
2.50	-34.40	-31.70	-32.90
3.00	-36.70	-32.00	-31.70
3.50	-37.70	-33.00	-30.50
4.00	-36.50	-34.20	-29.20
4.50	-35.30	-34.80	-28.50
5.00	-34.10	-35.60	-28.00

FREQ. PUSHING (MHz/V)
1.82
2.46
2.98
3.33
3.33
2.90
2.31
2.22
2.92
4.02

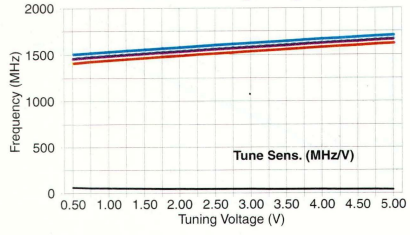
Frequency Pushing
(Supply Voltage 5V)



ROS-1605PV

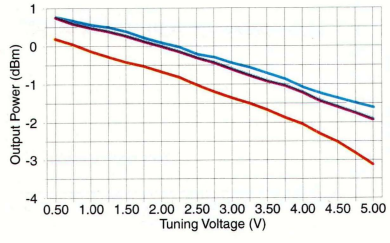
5V Tuning For PLL ICs- spec pg. 82

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

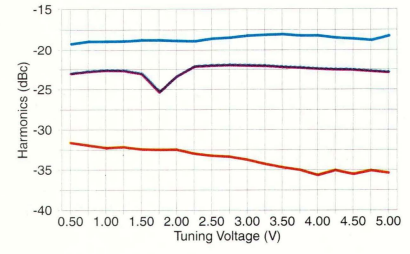


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	62.17	1465.51	1448.68	1432.50	0.73	0.72	0.17
0.75	56.88	1479.22	1462.90	1447.33	0.63	0.56	0.03
1.00	53.24	1492.08	1476.21	1461.10	0.52	0.45	-0.15
1.25	50.93	1504.40	1488.94	1474.21	0.46	0.36	-0.30
1.50	48.95	1516.36	1501.18	1486.75	0.34	0.24	-0.44
1.75	47.58	1528.00	1513.07	1498.90	0.18	0.10	-0.54
2.00	46.86	1539.52	1524.79	1510.79	0.05	-0.03	-0.69
2.25	45.99	1550.86	1536.29	1522.46	-0.06	-0.17	-0.83
2.50	45.84	1562.16	1547.75	1534.06	-0.25	-0.33	-1.03
2.75	45.30	1573.32	1559.07	1545.52	-0.33	-0.46	-1.21
3.00	44.93	1584.42	1570.30	1556.92	-0.48	-0.63	-1.37
3.25	44.56	1595.42	1581.44	1568.18	-0.60	-0.79	-1.52
3.50	43.88	1606.31	1592.41	1579.31	-0.75	-0.94	-1.69
3.75	43.48	1617.11	1603.28	1590.26	-0.90	-1.06	-1.89
4.00	42.88	1627.80	1614.00	1601.07	-1.12	-1.24	-2.06
4.25	42.07	1638.29	1624.52	1611.70	-1.27	-1.46	-2.31
4.50	40.88	1648.50	1634.74	1622.03	-1.40	-1.62	-2.53
4.75	39.40	1658.30	1644.58	1632.00	-1.53	-1.78	-2.83
5.00	37.50	1667.57	1653.96	1641.53	-1.65	-1.95	-3.14

Power Output



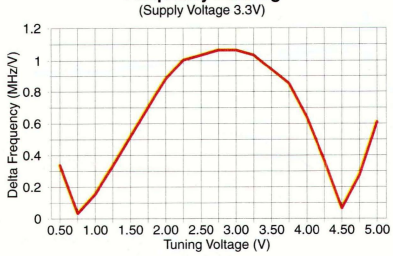
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.50	-19.36	-23.15	-31.68
0.75	-19.10	-22.88	-32.02
1.00	-19.10	-22.73	-32.33
1.25	-19.05	-22.78	-32.24
1.50	-18.95	-23.18	-32.54
1.75	-18.94	-25.47	-32.58
2.00	-19.01	-23.51	-32.56
2.25	-19.05	-22.24	-33.05
2.50	-18.75	-22.11	-33.32
2.75	-18.64	-22.08	-33.44
3.00	-18.40	-22.11	-33.82
3.25	-18.30	-22.15	-34.34
3.50	-18.23	-22.31	-34.75
3.75	-18.40	-22.40	-35.07
4.00	-18.39	-22.54	-35.71
4.25	-18.67	-22.66	-35.12
4.50	-18.76	-22.70	-35.61
4.75	-18.95	-22.85	-35.16
5.00	-18.42	-23.00	-35.46

FREQ. PUSHING (MHz/V)
0.33
0.03
0.15
0.33
0.52
0.70
0.88
1.00
1.03
1.06
1.06
1.03
0.94
0.85
0.64
0.36
0.06
0.27
0.61

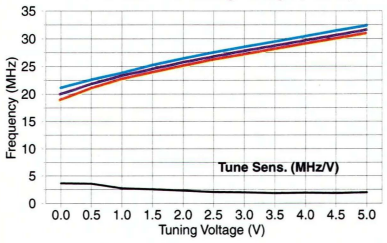
Frequency Pushing
(Supply Voltage 3.3V)



POS-50P

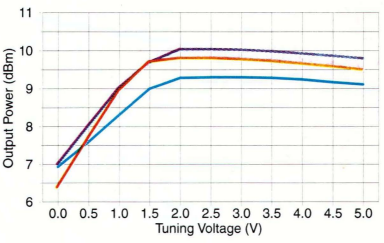
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

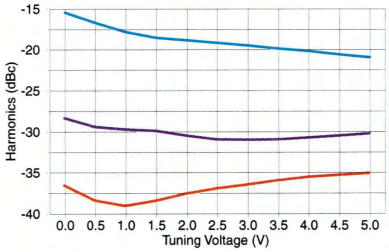


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	3.64	21.03	19.87	19.00	6.92	6.99	6.38
0.5	3.59	22.51	21.68	21.07	7.58	8.01	7.68
1.0	2.74	23.72	23.17	22.73	8.30	9.01	8.94
1.5	2.57	25.14	24.38	23.94	8.99	9.68	9.70
2.0	2.33	26.34	25.60	25.16	9.27	10.03	9.80
2.5	2.03	27.42	26.65	26.25	9.29	10.03	9.80
3.0	1.99	28.43	27.66	27.24	9.29	10.01	9.77
3.5	1.87	29.40	28.61	28.20	9.27	9.97	9.72
4.0	1.92	30.37	29.58	29.14	9.23	9.91	9.65
4.5	1.85	31.34	30.52	30.08	9.16	9.85	9.58
5.0	1.97	32.32	31.49	31.03	9.10	9.78	9.50

Power Output



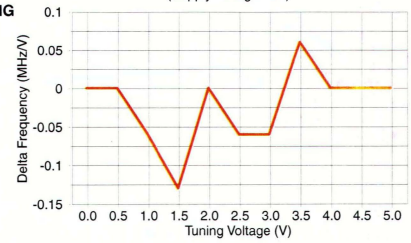
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-15.51	-28.42	-36.61
0.5	-16.74	-29.48	-38.42
1.0	-17.90	-29.78	-39.10
1.5	-18.60	-29.95	-38.48
2.0	-18.92	-30.54	-37.60
2.5	-19.22	-31.00	-36.99
3.0	-19.57	-31.04	-36.50
3.5	-19.95	-31.01	-35.98
4.0	-20.26	-30.78	-35.60
4.5	-20.69	-30.54	-35.34
5.0	-21.04	-30.28	-35.11

FREQ. PUSHING (MHz/V)
0.00
0.00
-0.06
-0.13
0.00
-0.06
-0.06
0.06
0.00
0.00
0.00

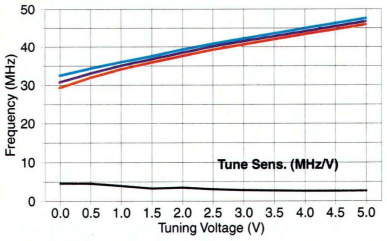
Frequency Pushing
(Supply Voltage 12V)



POS-75P

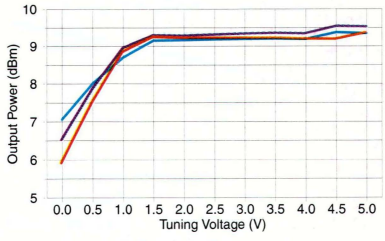
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

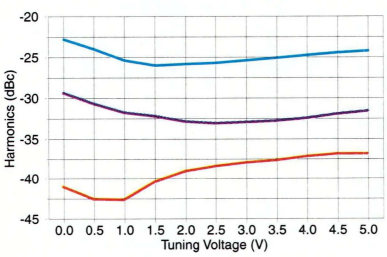


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	4.56	31.69	30.60	29.65	7.04	6.52	5.91
0.5	4.50	33.49	32.86	32.22	7.99	7.85	7.50
1.0	3.92	35.18	34.90	34.44	8.68	8.94	8.84
1.5	3.26	36.74	36.61	36.22	9.13	9.28	9.24
2.0	3.43	38.45	38.30	37.90	9.14	9.27	9.21
2.5	3.04	39.99	39.86	39.51	9.16	9.30	9.21
3.0	2.80	41.40	41.28	40.95	9.17	9.33	9.21
3.5	2.69	42.76	42.63	42.32	9.18	9.34	9.21
4.0	2.63	44.10	43.96	43.66	9.17	9.33	9.19
4.5	2.61	45.43	45.26	44.98	9.35	9.53	9.18
5.0	2.64	46.78	46.59	46.30	9.33	9.51	9.35

Power Output



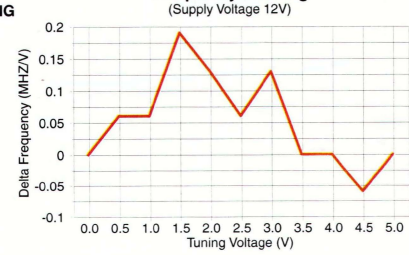
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-22.90	-29.40	-41.07
0.5	-24.07	-30.73	-42.57
1.0	-25.49	-31.82	-42.66
1.5	-26.11	-32.27	-40.44
2.0	-25.93	-32.93	-39.10
2.5	-25.79	-33.13	-38.46
3.0	-25.49	-32.99	-37.99
3.5	-25.17	-32.83	-37.67
4.0	-24.82	-32.49	-37.16
4.5	-24.50	-32.00	-36.83
5.0	-24.31	-31.65	-36.81

FREQ. PUSHING (MHz/V)
0.00
0.06
0.06
0.19
0.13
0.06
0.13
0.00
0.00
-0.06
0.00

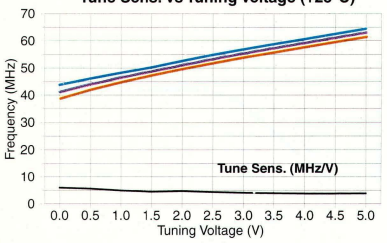
Frequency Pushing
(Supply Voltage 12V)



POS-100P

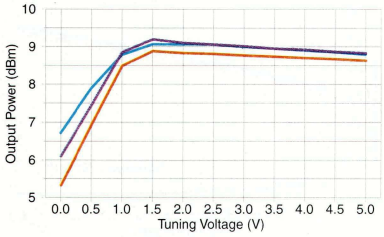
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

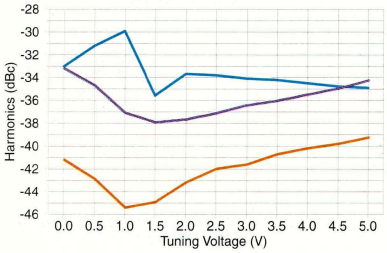


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	5.93	43.34	41.46	40.21	6.74	6.13	5.35
0.5	5.63	45.64	44.35	43.52	7.91	7.47	6.96
1.0	4.88	47.75	46.87	46.32	8.81	8.88	8.52
1.5	4.47	49.80	49.15	48.75	9.09	9.22	8.91
2.0	4.68	52.13	51.45	51.10	9.08	9.13	8.86
2.5	4.35	54.35	53.69	53.32	9.08	9.09	8.84
3.0	4.02	56.37	55.73	55.34	9.02	9.04	8.80
3.5	3.87	58.30	57.68	57.28	8.98	8.98	8.77
4.0	3.80	60.19	59.59	59.18	8.93	8.95	8.73
4.5	3.79	62.07	61.49	61.06	8.88	8.90	8.70
5.0	3.84	63.98	63.41	62.97	8.82	8.86	8.66

Power Output



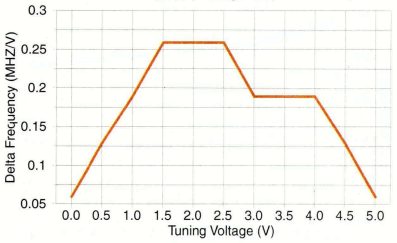
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-32.96	-33.12	-41.12
0.5	-31.13	-34.63	-42.80
1.0	-29.85	-37.02	-45.35
1.5	-35.52	-37.86	-44.86
2.0	-33.60	-37.60	-43.10
2.5	-33.73	-37.06	-41.89
3.0	-34.02	-36.35	-41.52
3.5	-34.13	-35.96	-40.63
4.0	-34.43	-35.43	-40.10
4.5	-34.71	-34.88	-39.71
5.0	-34.84	-34.17	-39.17

FREQ. PUSHING (MHz/V)
0.06
0.13
0.19
0.26
0.26
0.26
0.19
0.19
0.19
0.13
0.06

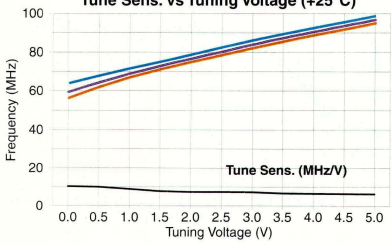
Frequency Pushing
(Supply Voltage 12V)



POS-150P

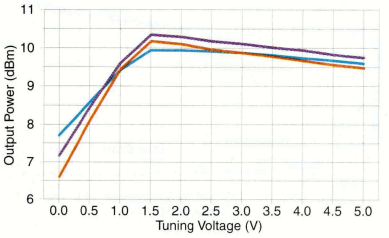
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

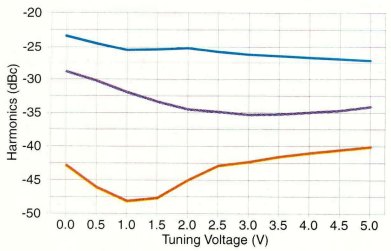


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	10.24	63.31	59.60	57.51	7.72	7.18	6.61
0.5	9.99	67.21	64.66	63.26	8.59	8.46	8.11
1.0	8.82	70.96	69.22	68.25	9.43	9.62	9.45
1.5	7.70	74.52	73.21	72.43	9.95	10.36	10.19
2.0	7.36	78.14	76.93	76.19	9.95	10.30	10.11
2.5	7.32	81.92	80.54	79.77	9.93	10.19	9.97
3.0	7.12	85.50	84.18	83.40	9.89	10.12	9.88
3.5	6.61	88.81	87.54	86.76	9.83	10.03	9.79
4.0	6.36	91.97	90.75	89.97	9.75	9.95	9.68
4.5	6.24	95.04	93.89	93.10	9.69	9.84	9.57
5.0	6.18	98.10	96.99	96.21	9.61	9.76	9.49

Power Output



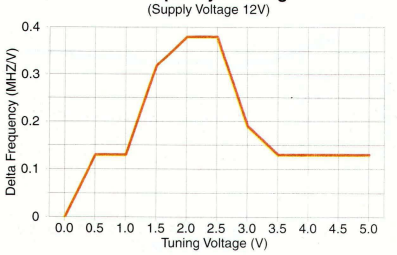
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-23.33	-28.83	-42.83
0.5	-24.44	-30.27	-46.11
1.0	-25.46	-31.96	-48.13
1.5	-25.37	-33.37	-47.70
2.0	-25.17	-34.51	-45.01
2.5	-25.73	-34.90	-42.90
3.0	-26.16	-35.33	-42.33
3.5	-26.40	-35.24	-41.57
4.0	-26.66	-34.99	-40.99
4.5	-26.88	-34.71	-40.55
5.0	-27.11	-34.11	-40.11

FREQ. PUSHING (MHz/V)
0.00
0.13
0.13
0.32
0.38
0.38
0.19
0.13
0.13
0.13
0.13

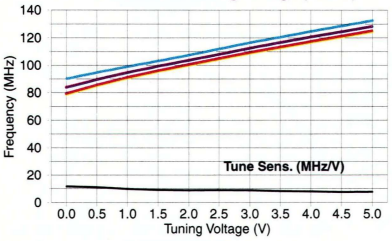
Frequency Pushing
(Supply Voltage 12V)



POS-200P

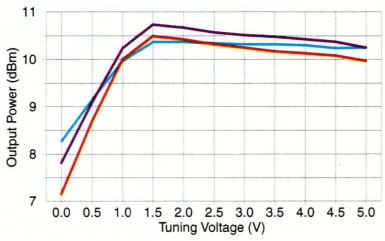
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

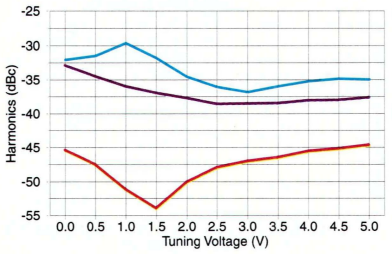


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	11.60	87.77	83.24	80.40	8.25	7.79	7.13
0.5	11.10	92.32	88.92	86.83	9.13	9.06	8.66
1.0	9.79	96.60	93.96	92.34	9.95	10.22	9.98
1.5	8.99	100.73	98.54	97.18	10.35	10.71	10.47
2.0	8.77	104.99	103.01	101.73	10.35	10.65	10.40
2.5	8.89	109.57	107.36	106.12	10.32	10.55	10.30
3.0	8.75	114.11	111.84	110.50	10.30	10.49	10.23
3.5	8.14	118.25	115.96	114.62	10.30	10.46	10.15
4.0	7.95	122.24	119.97	118.56	10.28	10.40	10.11
4.5	7.60	126.11	123.82	122.40	10.22	10.35	10.06
5.0	7.72	129.94	127.66	126.28	10.23	10.23	9.95

Power Output



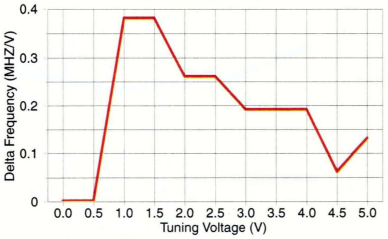
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-32.16	-33.00	-45.50
0.5	-31.60	-34.60	-47.60
1.0	-29.76	-36.09	-51.26
1.5	-31.90	-37.06	-54.06
2.0	-34.67	-37.84	-50.17
2.5	-36.20	-38.70	-48.03
3.0	-36.97	-38.64	-47.14
3.5	-36.08	-38.58	-46.58
4.0	-35.35	-38.18	-45.68
4.5	-34.97	-38.13	-45.30
5.0	-35.08	-37.75	-44.75

FREQ. PUSHING (MHz/V)
0.00
0.00
0.38
0.38
0.26
0.26
0.19
0.19
0.19
0.06
0.13

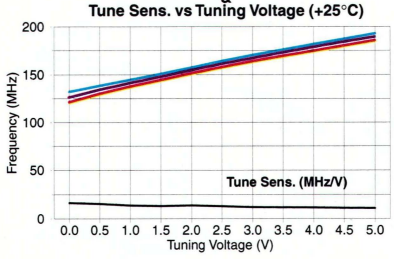
Frequency Pushing
(Supply Voltage 12V)



POS-300P

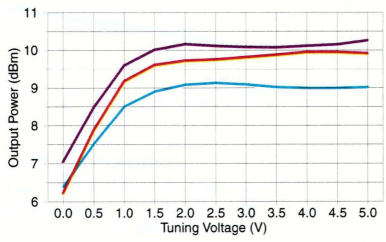
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

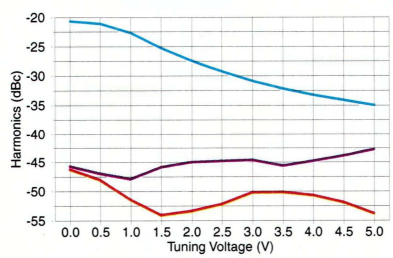


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	16.26	130.97	125.58	121.94	6.36	7.02	6.21
0.5	15.16	137.44	133.44	130.82	7.48	8.45	7.85
1.0	13.58	143.41	140.40	138.32	8.47	9.57	9.16
1.5	13.09	149.57	147.01	145.24	8.87	9.98	9.59
2.0	13.65	156.17	153.67	152.09	9.05	10.13	9.70
2.5	12.81	162.85	160.26	158.44	9.10	10.08	9.73
3.0	11.80	169.07	166.24	164.40	9.06	10.05	9.79
3.5	11.45	174.77	172.00	170.06	8.99	10.04	9.85
4.0	11.24	180.29	177.66	175.50	8.96	10.08	9.92
4.5	11.05	186.11	183.22	180.88	8.96	10.12	9.92
5.0	10.75	191.68	188.65	186.34	8.98	10.22	9.89

Power Output



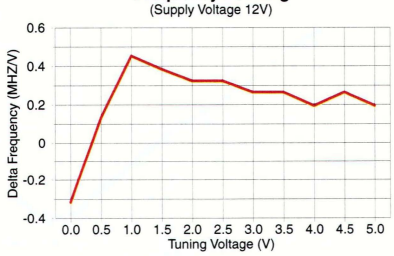
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-20.87	-45.87	-46.37
0.5	-21.30	-47.14	-48.14
1.0	-22.87	-48.04	-51.54
1.5	-25.50	-46.00	-54.17
2.0	-27.65	-45.15	-53.48
2.5	-29.45	-44.95	-52.29
3.0	-31.10	-44.77	-50.27
3.5	-32.42	-45.76	-50.26
4.0	-33.45	-44.95	-50.79
4.5	-34.33	-43.99	-51.99
5.0	-35.22	-42.89	-53.89

FREQ. PUSHING (MHz/V)
-0.32
0.13
0.45
0.38
0.32
0.32
0.26
0.26
0.19
0.26
0.19

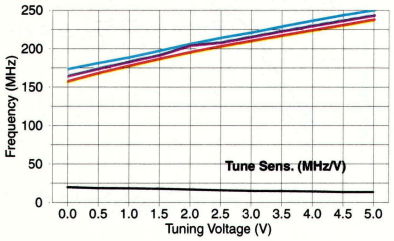
Frequency Pushing
(Supply Voltage 12V)



POS-400P

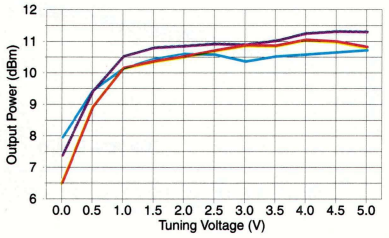
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

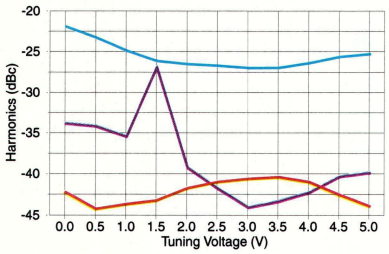


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	19.74	171.24	165.27	161.07	7.95	7.40	6.54
0.5	18.42	179.35	174.81	171.96	9.44	9.43	8.94
1.0	17.91	186.89	183.80	181.54	10.14	10.54	10.17
1.5	17.51	195.32	192.53	190.53	10.44	10.81	10.38
2.0	16.59	204.34	205.03	199.16	10.60	10.86	10.54
2.5	15.48	212.15	208.90	206.87	10.58	10.93	10.73
3.0	14.87	219.26	216.39	213.96	10.36	10.91	10.89
3.5	14.40	227.09	223.63	220.94	10.52	11.03	10.88
4.0	14.01	234.56	230.71	227.86	10.58	11.26	11.07
4.5	13.31	241.66	237.48	234.56	10.65	11.32	11.01
5.0	13.22	247.96	244.05	241.36	10.72	11.31	10.84

Power Output



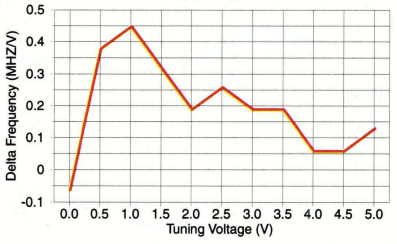
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-21.95	-33.78	-42.12
0.5	-23.31	-34.15	-44.15
1.0	-24.91	-35.41	-43.58
1.5	-26.14	-26.81	-43.14
2.0	-26.51	-39.17	-41.67
2.5	-26.73	-41.73	-40.90
3.0	-27.02	-44.02	-40.52
3.5	-26.97	-43.31	-40.31
4.0	-26.41	-42.24	-40.91
4.5	-25.64	-40.31	-42.48
5.0	-25.30	-39.80	-43.80

FREQ. PUSHING (MHz/V)
-0.06
0.38
0.45
0.32
0.19
0.26
0.19
0.19
0.06
0.06
0.13

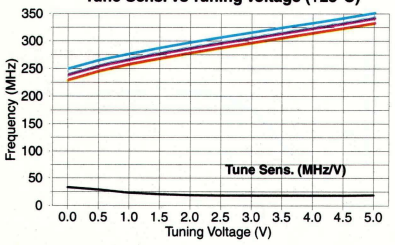
Frequency Pushing (Supply Voltage 12V)



POS-535P

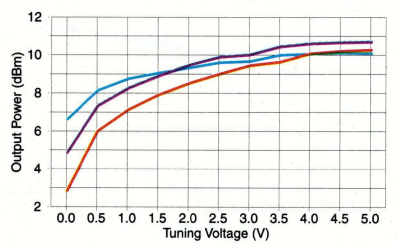
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

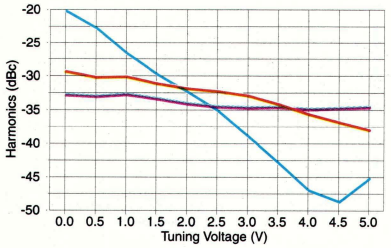


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	33.00	245.51	240.36	236.08	6.62	4.90	2.90
0.5	28.85	260.45	255.82	252.18	8.14	7.35	6.04
1.0	23.30	272.41	268.01	264.56	8.75	8.28	7.17
1.5	20.66	282.95	278.66	275.23	9.05	8.93	7.95
2.0	18.98	292.72	288.36	284.88	9.32	9.49	8.55
2.5	18.30	302.09	297.57	294.20	9.60	9.91	9.04
3.0	17.86	311.13	306.52	303.36	9.66	10.03	9.48
3.5	17.87	319.94	315.44	312.35	9.99	10.46	9.67
4.0	18.19	328.69	324.51	321.29	10.06	10.61	10.11
4.5	18.40	337.57	333.72	330.19	10.10	10.67	10.24
5.0	18.81	346.97	343.10	339.19	10.08	10.70	10.30

Power Output



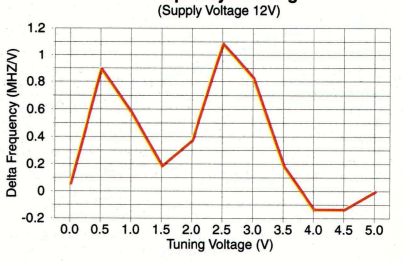
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-20.22	-32.72	-29.22
0.5	-22.78	-32.95	-30.11
1.0	-26.67	-32.67	-30.00
1.5	-29.81	-33.31	-30.98
2.0	-32.37	-34.04	-31.70
2.5	-35.13	-34.47	-32.13
3.0	-38.94	-34.61	-32.78
3.5	-42.85	-34.52	-34.02
4.0	-47.00	-34.83	-35.50
4.5	-48.71	-34.71	-36.71
5.0	-45.21	-34.54	-37.87

FREQ. PUSHING (MHz/V)
0.06
0.90
0.58
0.19
0.38
1.09
0.83
0.19
-0.13
-0.13
0.00

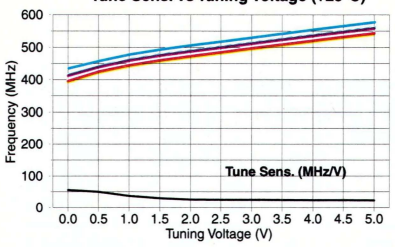
Frequency Pushing (Supply Voltage 12V)



POS-765P

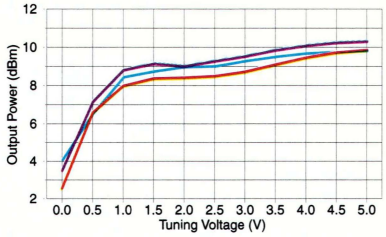
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

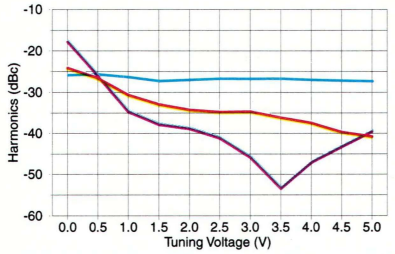


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	54.63	427.70	416.18	407.58	4.07	3.55	2.63
0.5	49.27	449.76	442.16	436.07	6.54	7.19	6.64
1.0	36.64	469.81	462.17	455.87	8.44	8.85	8.03
1.5	28.99	485.44	477.47	470.87	8.74	9.18	8.42
2.0	25.11	498.69	490.47	483.76	8.96	9.04	8.46
2.5	24.28	510.52	502.62	496.03	9.01	9.30	8.54
3.0	24.29	522.70	514.74	508.14	9.28	9.55	8.77
3.5	23.93	535.01	526.77	520.09	9.50	9.88	9.14
4.0	23.43	547.10	538.57	531.78	9.68	10.11	9.51
4.5	22.81	558.87	550.08	543.16	9.76	10.27	9.77
5.0	22.46	570.45	561.39	554.32	9.81	10.33	9.90

Power Output



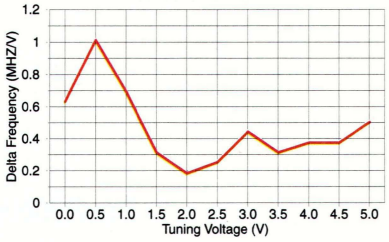
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-25.87	-17.54	-23.87
0.5	-25.69	-25.85	-26.35
1.0	-26.35	-34.51	-30.35
1.5	-27.29	-37.62	-32.62
2.0	-27.00	-38.67	-34.00
2.5	-26.71	-40.88	-34.54
3.0	-26.75	-45.59	-34.42
3.5	-26.71	-53.21	-35.88
4.0	-27.00	-46.83	-37.17
4.5	-27.22	-43.05	-39.39
5.0	-27.34	-39.34	-40.51

FREQ. PUSHING (MHz/V)
0.64
1.02
0.70
0.32
0.19
0.26
0.45
0.32
0.38
0.38
0.51

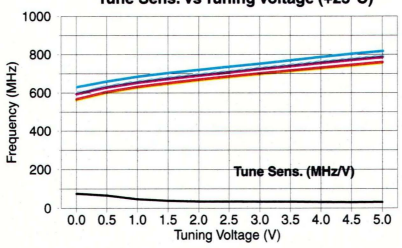
Frequency Pushing (Supply Voltage 12V)



POS-1025P

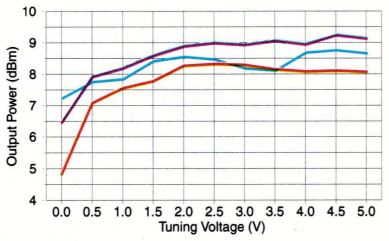
5V Tuning For PLL ICs- spec pg. 83

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

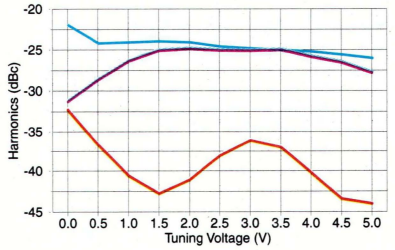


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.0	74.25	618.42	600.96	587.81	7.23	6.49	4.87
0.5	64.32	648.48	635.61	626.06	7.75	7.94	7.12
1.0	45.46	672.76	660.32	651.44	7.84	8.21	7.59
1.5	37.02	691.93	679.74	671.51	8.41	8.61	7.81
2.0	33.63	708.39	696.92	689.26	8.55	8.91	8.30
2.5	33.85	723.86	713.86	706.14	8.46	9.01	8.36
3.0	33.14	739.79	730.49	721.74	8.18	8.95	8.33
3.5	32.01	756.87	746.67	736.54	8.10	9.08	8.19
4.0	30.49	774.28	762.14	750.97	8.68	8.96	8.12
4.5	29.59	790.17	777.03	765.28	8.75	9.26	8.14
5.0	29.72	805.25	791.89	779.85	8.65	9.15	8.10

Power Output



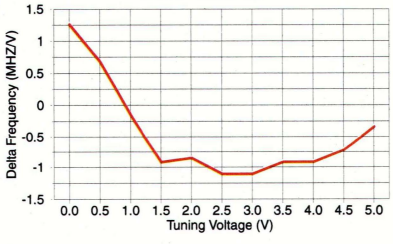
Harmonics



V TUNE	HARMONICS (dBc) F2	F3	F4
0.0	-21.96	-31.12	-32.12
0.5	-24.17	-28.51	-36.51
1.0	-24.05	-26.22	-40.38
1.5	-23.94	-24.94	-42.60
2.0	-24.06	-24.73	-40.89
2.5	-24.58	-24.92	-37.92
3.0	-24.79	-24.96	-35.96
3.5	-25.00	-24.83	-36.83
4.0	-25.21	-25.71	-40.05
4.5	-25.59	-26.42	-43.25
5.0	-26.02	-27.68	-43.85

FREQ. PUSHING (MHz/V)
1.28
0.70
-0.13
-0.90
-0.83
-1.09
-1.09
-0.90
-0.90
-0.70
-0.32

Frequency Pushing (Supply Voltage 12V)



VOLTAGE CONTROLLED OSCILLATORS

LOW NOISE *SURFACE MOUNT*

JCOS

ROS

125 to 1114MHz

MODEL◆ NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3 dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Page #	CASE STYLE Note B	CONNECTION	PRICE $ Qty. (1-9)
JCOS-820WLN	780-860		+9	0	20	-60	-90	-112	-132	-150	4.5	0.3	8	-13	-8	2000	9	25	104	BG419	jd	49.95
JCOS-820BLN	807-832		+3	1	14	-57	-88	-112	-132	-151	0.4	0.4	6	-24	-20	2000	10	25	104	BG419	jd	49.95
JCOS-175LN	125-175		+3.7	1	17	--	-95	-118	-138	-158	0.08	0.05	3.5	-25	-20	2900	12	20	105	BG419	jd	49.95
JCOS-1100LN	1079-1114		+8.5	0	20	-60	-88	-110	-130	-150	7.5	0.5	4.5	-15	-20	2000	8	25	105	BG419	jd	49.95
ROS-810LN	760-810		+5	0.5	10	--	-90	-115	-135	-155	1.8	0.5	8-10	-24	-18	6000	8	20	106	CK605	kg	49.95

PLUG-IN

POSA

118 to 960MHz

POSA-138	118-138		+5	1	16	-72	-100	-125	-145	-163	0.07	0.03	2.3	-40	-30	2000	12	25	106	C07	jr	46.95
POSA-158	138-158		+5	1	16	-72	-100	-125	-145	-163	0.07	0.03	2.4	-40	-25	2000	12	25	107	C07	jr	46.95
POSA-960	800-960		+16	1	15	--	-84	-112	-130	-150	2.0	0.3	17-22	-30	-16	2000	15	50	107	C07	mj	49.95

NOTES:

❑ Surface Mount Non-hermetic

◆ Aqueous washable.

A. General Quality Control Procedures, Environmental specifications, Hi-Rel, and MIL description are given in Mini-Circuits RF/IF Designer's Guide.

B. Connector types, case mounted options, and case finishes are given with "Outline Drawings & Case Style Dimensions" on pages 112 and 113.

C. Environmental specifications and re-flow soldering Information available in mini-circuits RF/IF Designer's Guide.

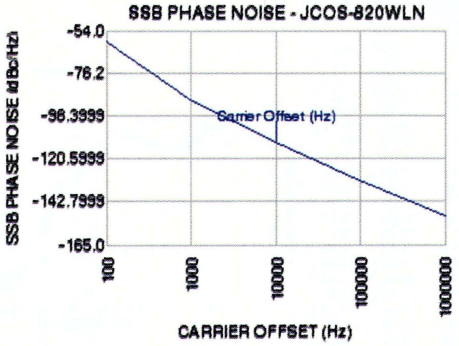
D. Prices and Specifications subject to change without notice.
1. Absolute Maximum Supply Voltage (V_{CC}) & Tuning Voltage (V_{tune}):
2. Operating Temperature: -55°C to +85°C

Model	(V_{CC})	(V_{tune})
JCOS 820WLN	+15V	+24V
JCOS-820BLN	+15V	+24V
JCOS-175LN	+15V	+24V
JCOS-1100LN	+15V	+24V
POSA-138	+15V	+24V
POSA-158	+15V	+24V
POSA-960	+16V	+16V
ROS-810LN	+9V	+12V

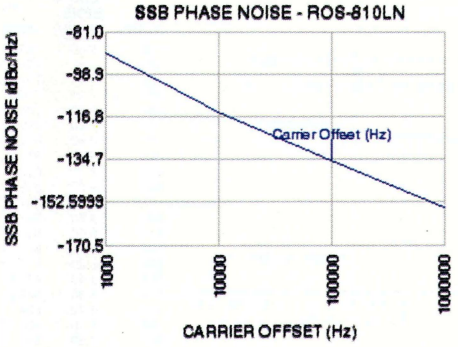
PIN CONNECTIONS see case style and outline drawings

PORT	jd	jr	kg	mj
RF OUT	7	9	10	1
V-CC	1	12	14	4
V-TUNE	8	3	2	16
GND EXT	all others	all others	all others	all others

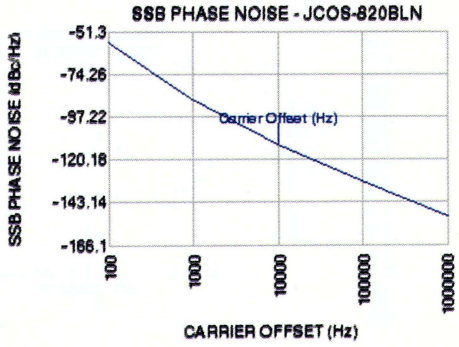
JCOS-820WLN



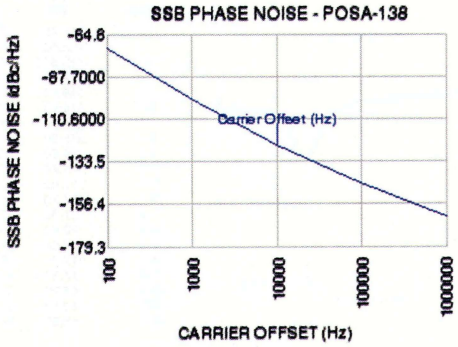
ROS-810LN



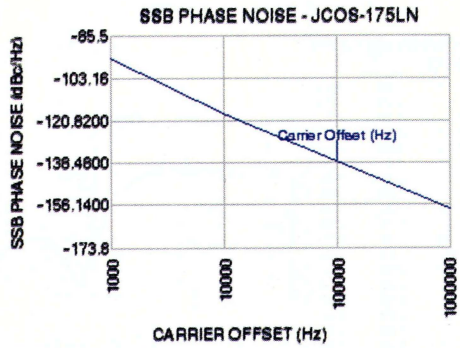
JCOS-820BLN



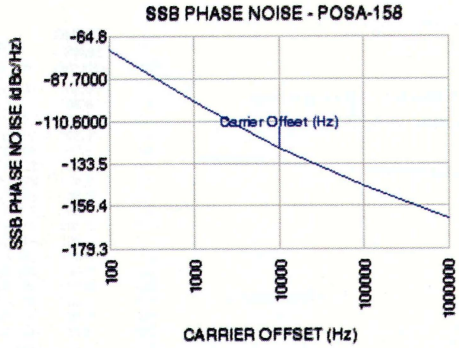
POSA-138



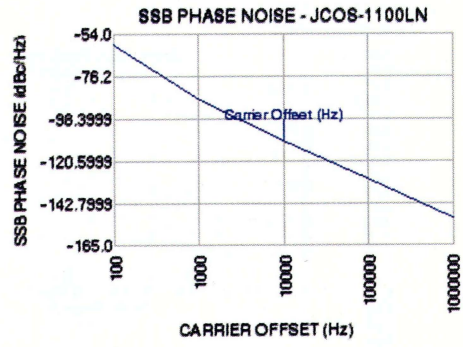
JCOS-175LN



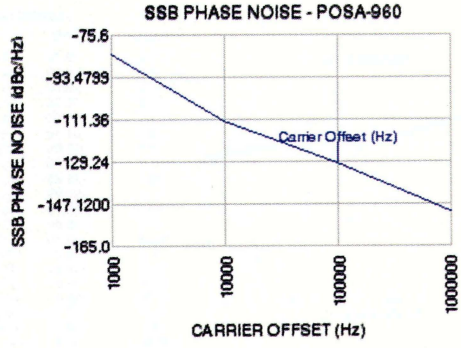
POSA-158



JCOS-1100LN



POSA-960

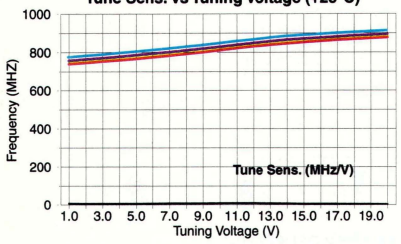


JCOS-820WLN

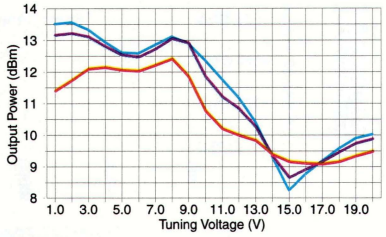
Low Noise- spec pg. 102

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	8.30	756.34	755.00	753.18	13.51	13.14	11.37
2.0	6.80	762.99	761.80	759.71	13.56	13.20	11.71
3.0	6.60	769.65	768.40	766.04	13.33	13.09	12.07
4.0	7.00	776.80	775.50	772.67	12.94	12.79	12.12
5.0	7.50	784.48	783.00	779.80	12.61	12.52	12.03
6.0	8.20	792.70	791.10	787.54	12.58	12.45	12.00
7.0	8.60	801.36	799.70	795.75	12.85	12.70	12.19
8.0	8.70	810.21	808.40	804.29	13.11	13.03	12.38
9.0	8.50	819.17	816.90	813.71	12.89	12.89	11.82
10.0	9.90	828.54	826.80	824.30	12.36	11.84	10.74
11.0	10.10	837.95	836.80	834.42	11.76	11.20	10.17
12.0	9.60	847.45	846.40	843.77	11.18	10.82	9.97
13.0	9.00	856.62	855.30	852.27	10.41	10.24	9.80
14.0	8.00	865.04	863.30	859.54	9.31	9.32	9.36
15.0	5.20	870.24	868.60	865.45	8.24	8.64	9.13
16.0	5.40	875.01	874.00	871.44	8.76	8.90	9.08
17.0	5.30	880.21	879.30	876.98	9.17	9.14	9.06
18.0	4.70	884.81	883.90	881.80	9.57	9.44	9.13
19.0	4.10	888.93	888.00	885.96	9.89	9.72	9.31
20.0	3.80	892.75	891.80	889.70	10.02	9.86	9.45

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

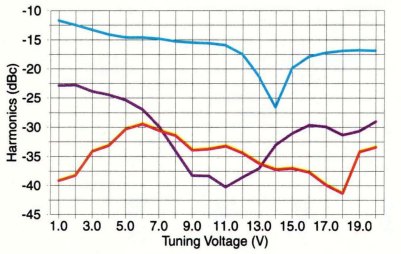


Power Output

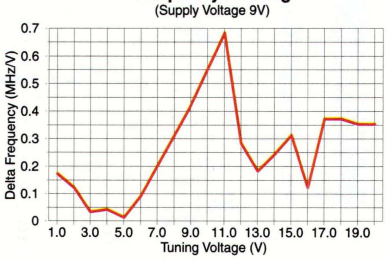


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-11.70	-22.90	-39.20	0.17
2.0	-12.50	-22.80	-38.30	0.12
3.0	-13.30	-23.90	-34.20	0.03
4.0	-14.10	-24.50	-33.20	0.04
5.0	-14.60	-25.40	-30.40	0.01
6.0	-14.60	-27.00	-29.50	0.09
7.0	-14.80	-29.90	-30.60	0.20
8.0	-15.30	-34.10	-31.50	0.31
9.0	-15.50	-38.30	-34.00	0.42
10.0	-15.60	-38.40	-33.80	0.55
11.0	-15.90	-40.30	-33.30	0.68
12.0	-17.50	-38.60	-34.50	0.28
13.0	-21.30	-37.10	-36.30	0.18
14.0	-26.60	-33.10	-37.30	0.24
15.0	-19.90	-31.10	-37.10	0.31
16.0	-17.90	-29.70	-37.80	0.12
17.0	-17.20	-30.00	-40.00	0.37
18.0	-16.90	-31.40	-41.40	0.37
19.0	-16.80	-30.70	-34.30	0.35
20.0	-16.90	-29.10	-33.50	0.35

Harmonics



Frequency Pushing
(Supply Voltage 9V)

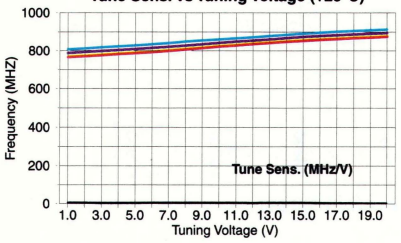


JCOS-820BLN

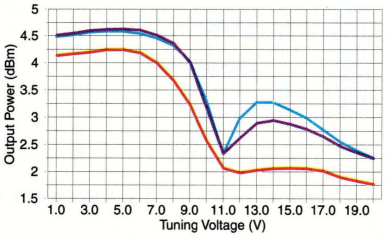
Low Noise- spec pg. 102

V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	6.50	788.05	786.20	782.90	4.48	4.50	4.12
2.0	6.30	793.33	791.46	788.11	4.51	4.54	4.15
3.0	5.00	798.36	796.46	793.02	4.56	4.59	4.18
4.0	5.10	803.54	801.58	798.08	4.58	4.61	4.23
5.0	5.50	809.07	807.04	803.43	4.58	4.62	4.23
6.0	6.00	815.13	813.00	809.27	4.54	4.60	4.17
7.0	6.40	821.70	819.43	815.71	4.45	4.50	3.98
8.0	6.80	829.56	826.18	822.80	4.32	4.35	3.66
9.0	6.80	835.18	832.93	830.29	4.02	3.99	3.21
10.0	7.10	841.21	840.08	837.80	3.31	3.16	2.55
11.0	6.60	847.38	846.70	844.77	2.32	2.32	2.05
12.0	5.60	852.63	852.27	851.22	2.97	2.61	1.96
13.0	6.30	858.98	858.52	857.53	3.27	2.88	2.01
14.0	6.20	865.29	864.76	863.67	3.27	2.93	2.04
15.0	5.90	871.22	870.62	869.41	3.13	2.86	2.05
16.0	5.30	876.52	875.88	874.57	2.98	2.77	2.04
17.0	4.70	881.30	880.60	879.17	2.77	2.64	2.00
18.0	4.20	885.56	884.84	883.33	2.55	2.46	1.88
19.0	3.70	889.31	888.55	887.00	2.39	2.34	1.81
20.0	3.30	892.61	891.84	890.23	2.25	2.23	1.75

Frequency vs Tuning Voltage & Tune Sens. vs Tuning Voltage (+25°C)

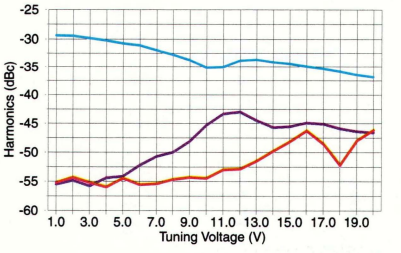


Power Output

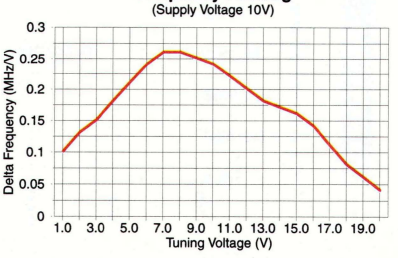


V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-29.40	-55.60	-55.30	0.10
2.0	-29.50	-54.90	-54.40	0.13
3.0	-29.90	-55.90	-55.30	0.15
4.0	-30.30	-54.50	-56.10	0.18
5.0	-30.80	-54.20	-54.60	0.21
6.0	-31.10	-52.30	-55.70	0.24
7.0	-32.00	-50.80	-55.50	0.26
8.0	-32.80	-50.10	-54.80	0.26
9.0	-33.80	-48.20	-54.40	0.25
10.0	-35.20	-45.40	-54.60	0.24
11.0	-35.10	-43.40	-53.10	0.22
12.0	-33.90	-43.10	-53.00	0.20
13.0	-33.70	-44.60	-51.60	0.18
14.0	-34.20	-45.80	-49.90	0.17
15.0	-34.50	-45.60	-48.30	0.16
16.0	-35.00	-45.00	-46.40	0.14
17.0	-35.40	-45.20	-48.70	0.11
18.0	-35.90	-46.00	-52.30	0.08
19.0	-36.50	-46.50	-48.10	0.06
20.0	-36.90	-46.70	-46.30	0.04

Harmonics



Frequency Pushing
(Supply Voltage 10V)



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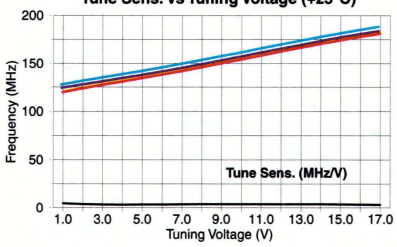
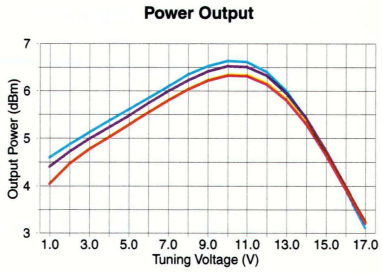
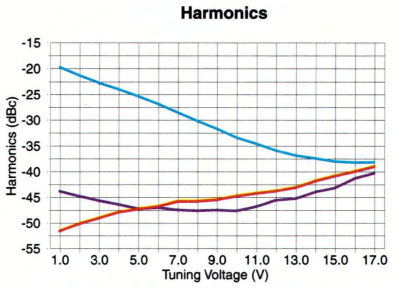


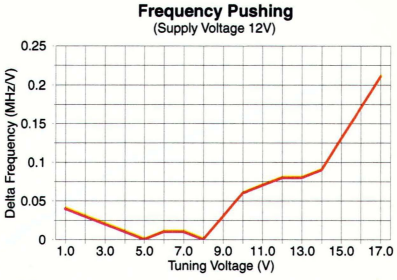
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	4.77	120.86	120.86	121.38	4.54	4.40	4.04
2.0	3.86	124.92	124.72	124.90	4.81	4.71	4.46
3.0	3.51	128.55	128.23	128.24	5.06	4.98	4.76
4.0	3.41	132.06	131.64	131.52	5.31	5.22	5.01
5.0	3.45	135.60	135.09	134.87	5.55	5.46	5.27
6.0	3.60	139.27	138.69	138.39	5.79	5.73	5.53
7.0	3.79	143.11	142.48	142.13	6.04	5.99	5.79
8.0	3.97	147.09	146.45	146.06	6.29	6.22	6.02
9.0	4.08	151.17	150.53	150.13	6.47	6.41	6.21
10.0	4.11	155.29	154.64	154.24	6.58	6.52	6.32
11.0	4.11	159.39	158.74	158.34	6.56	6.50	6.31
12.0	4.09	163.50	162.84	162.42	6.35	6.32	6.13
13.0	4.04	167.57	166.88	166.43	5.95	5.94	5.79
14.0	3.94	171.51	170.81	170.37	5.36	5.41	5.28
15.0	3.79	175.30	174.61	174.17	4.64	4.73	4.63
16.0	3.60	178.90	178.20	177.78	3.87	3.99	3.92
17.0	3.37	182.28	181.58	181.15	3.06	3.24	3.20





V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-19.69	-43.77	-51.50
2.0	-21.24	-44.70	-50.08
3.0	-22.68	-45.56	-48.98
4.0	-23.91	-46.31	-47.81
5.0	-25.29	-47.11	-47.24
6.0	-26.78	-46.91	-46.74
7.0	-28.43	-47.35	-45.73
8.0	-30.13	-47.51	-45.74
9.0	-31.61	-47.36	-45.40
10.0	-33.40	-47.55	-44.74
11.0	-34.55	-46.68	-44.18
12.0	-35.89	-45.46	-43.74
13.0	-36.83	-45.18	-43.04
14.0	-37.41	-43.92	-41.80
15.0	-37.98	-43.11	-40.84
16.0	-38.20	-41.26	-39.93
17.0	-38.17	-40.28	-38.99

V TUNE	FREQ. PUSHING (MHz/V)
1.0	0.04
2.0	0.03
3.0	0.02
4.0	0.01
5.0	0.00
6.0	0.01
7.0	0.01
8.0	0.00
9.0	0.03
10.0	0.06
11.0	0.07
12.0	0.08
13.0	0.08
14.0	0.09
15.0	0.13
16.0	0.17
17.0	0.21



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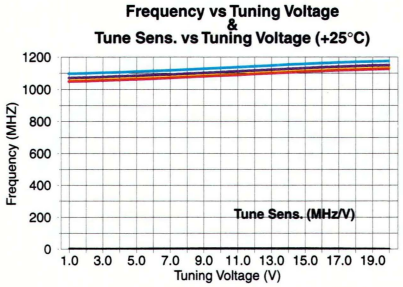
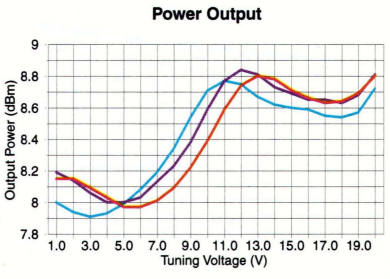
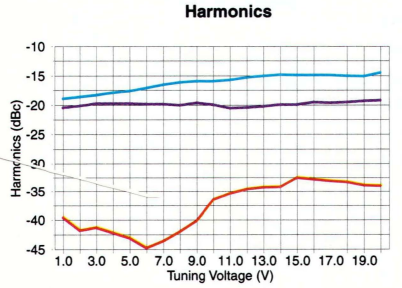


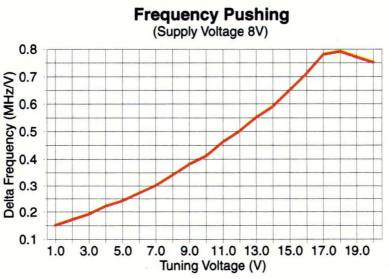
V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	4.20	1075.49	1071.24	1068.42	8.00	8.19	8.15
2.0	3.60	1079.06	1074.27	1071.86	7.94	8.14	8.15
3.0	3.50	1082.46	1078.30	1075.24	7.91	8.06	8.09
4.0	3.60	1085.88	1081.87	1078.78	7.93	8.00	8.03
5.0	3.70	1089.45	1085.62	1082.57	7.99	8.00	7.97
6.0	4.00	1093.29	1089.59	1086.67	8.08	8.03	7.97
7.0	4.30	1097.49	1093.85	1091.01	8.19	8.13	8.01
8.0	4.60	1102.04	1098.43	1095.61	8.34	8.23	8.09
9.0	4.80	1106.78	1103.26	1100.42	8.54	8.38	8.22
10.0	4.90	1111.61	1108.17	1105.35	8.71	8.59	8.39
11.0	4.80	1116.51	1113.02	1110.26	8.77	8.77	8.59
12.0	5.00	1121.67	1117.97	1115.16	8.75	8.84	8.74
13.0	5.10	1126.97	1123.06	1120.01	8.67	8.81	8.80
14.0	5.20	1132.08	1128.23	1124.96	8.62	8.73	8.78
15.0	4.90	1136.77	1133.13	1129.85	8.60	8.69	8.71
16.0	4.40	1141.04	1137.50	1134.33	8.59	8.65	8.66
17.0	3.90	1144.88	1141.36	1138.28	8.55	8.65	8.63
18.0	3.40	1148.24	1144.74	1141.69	8.54	8.63	8.64
19.0	2.90	1151.02	1147.64	1144.62	8.57	8.68	8.69
20.0	2.40	1153.13	1150.02	1147.15	8.72	8.81	8.80





V TUNE	HARMONICS (dBc) F2	F3	F4
1.0	-18.90	-20.40	-39.60
2.0	-18.60	-20.10	-41.80
3.0	-18.30	-19.70	-41.30
4.0	-17.90	-19.70	-42.20
5.0	-17.60	-19.70	-43.10
6.0	-17.10	-19.80	-44.80
7.0	-16.50	-19.80	-43.60
8.0	-16.10	-20.00	-42.00
9.0	-15.90	-19.60	-40.10
10.0	-15.90	-19.90	-36.50
11.0	-15.70	-20.50	-35.40
12.0	-15.30	-20.40	-34.60
13.0	-15.00	-20.20	-34.30
14.0	-14.80	-19.90	-34.20
15.0	-14.90	-19.90	-32.50
16.0	-14.90	-19.50	-32.80
17.0	-14.90	-19.60	-33.10
18.0	-15.00	-19.50	-33.30
19.0	-15.10	-19.30	-33.90
20.0	-14.50	-19.20	-34.00

V TUNE	FREQ. PUSHING (MHz/V)
1.0	0.15
2.0	0.17
3.0	0.19
4.0	0.22
5.0	0.24
6.0	0.27
7.0	0.30
8.0	0.34
9.0	0.38
10.0	0.41
11.0	0.46
12.0	0.50
13.0	0.55
14.0	0.59
15.0	0.65
16.0	0.71
17.0	0.78
18.0	0.79
19.0	0.77
20.0	0.75



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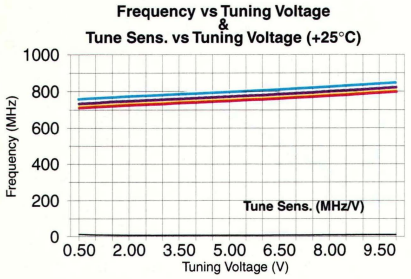
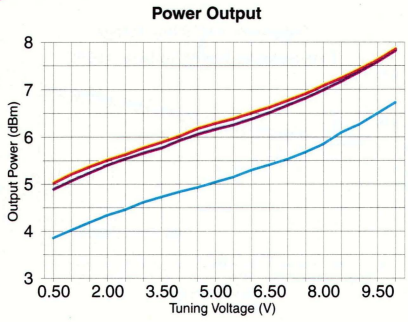
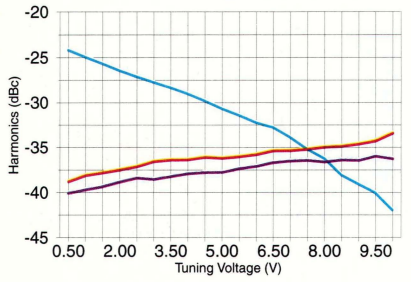
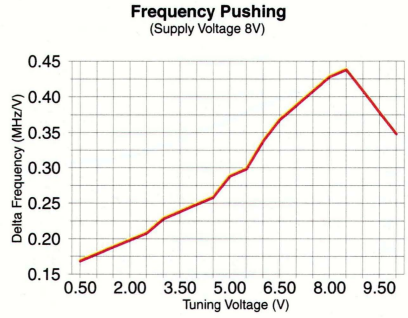


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
0.50	13.40	744.77	741.37	738.16	3.88	4.92	5.05
1.00	10.67	749.99	746.70	743.58	4.05	5.10	5.24
1.50	9.41	754.66	751.41	748.30	4.21	5.27	5.40
2.00	8.68	759.00	755.75	752.62	4.36	5.43	5.54
2.50	8.26	763.14	759.88	756.72	4.48	5.57	5.66
3.00	8.06	767.20	763.91	760.70	4.64	5.69	5.80
3.50	7.93	771.20	767.88	764.62	4.75	5.80	5.92
4.00	7.92	775.20	771.84	768.53	4.86	5.96	6.05
4.50	8.02	779.26	775.85	772.49	4.95	6.09	6.21
5.00	8.16	783.39	779.93	776.49	5.06	6.19	6.32
5.50	8.38	787.64	784.12	780.62	5.17	6.29	6.42
6.00	8.66	792.02	788.45	784.87	5.32	6.41	6.54
6.50	9.00	796.59	792.95	789.29	5.43	6.55	6.66
7.00	9.36	801.34	797.63	793.89	5.55	6.70	6.80
7.50	9.76	806.29	802.51	798.68	5.70	6.85	6.94
8.00	10.18	811.45	807.60	803.69	5.87	7.02	7.11
8.50	10.50	816.77	812.85	808.88	6.12	7.20	7.27
9.00	10.82	822.25	818.26	814.22	6.29	7.40	7.45
9.50	10.98	827.81	823.75	819.67	6.52	7.61	7.65
10.00	10.94	833.38	829.22	825.13	6.75	7.85	7.88





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
0.50	-24.08	-39.90	-38.65	0.17
1.00	-24.82	-39.55	-37.97	0.18
1.50	-25.54	-39.18	-37.68	0.19
2.00	-26.34	-38.70	-37.36	0.20
2.50	-27.01	-38.24	-36.99	0.21
3.00	-27.60	-38.41	-36.43	0.23
3.50	-28.19	-38.09	-36.26	0.24
4.00	-28.87	-37.76	-36.24	0.25
4.50	-29.68	-37.63	-35.96	0.26
5.00	-30.54	-37.62	-36.07	0.29
5.50	-31.29	-37.21	-35.90	0.30
6.00	-32.10	-36.95	-35.65	0.34
6.50	-32.64	-36.53	-35.24	0.37
7.00	-33.75	-36.36	-35.23	0.39
7.50	-35.09	-36.31	-35.07	0.41
8.00	-36.11	-36.48	-34.84	0.43
8.50	-37.96	-36.25	-34.74	0.44
9.00	-38.97	-36.32	-34.49	0.41
9.50	-39.89	-35.82	-34.14	0.38
10.00	-41.82	-36.12	-33.28	0.35



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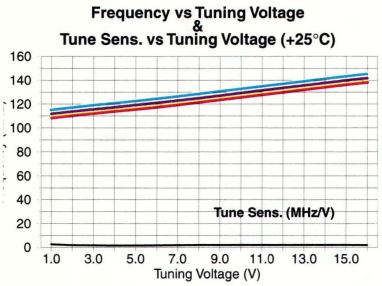
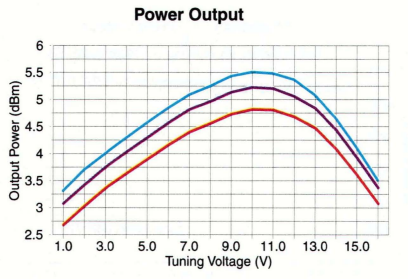
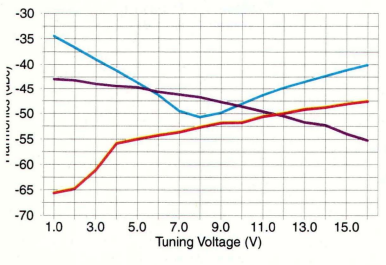
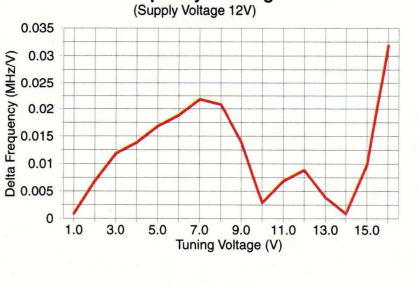


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	2.71	113.26	112.87	112.65	3.33	3.10	2.70
2.0	2.02	115.30	114.90	114.64	3.72	3.44	3.05
3.0	1.81	117.13	116.71	116.43	4.02	3.77	3.38
4.0	1.75	118.89	118.46	118.15	4.31	4.05	3.65
5.0	1.76	120.68	120.22	119.89	4.59	4.32	3.92
6.0	1.84	122.54	122.05	121.70	4.86	4.59	4.18
7.0	1.94	124.51	124.00	123.62	5.11	4.84	4.42
8.0	2.06	126.59	126.06	125.66	5.27	4.99	4.58
9.0	2.14	128.73	128.20	127.79	5.45	5.16	4.75
10.0	2.17	130.90	130.37	129.95	5.53	5.25	4.84
11.0	2.17	133.08	132.54	132.12	5.50	5.23	4.83
12.0	2.15	135.24	134.69	134.26	5.39	5.08	4.70
13.0	2.13	137.37	136.81	136.33	5.10	4.86	4.49
14.0	2.11	139.48	138.93	138.49	4.67	4.46	4.11
15.0	2.07	141.54	140.99	140.56	4.13	3.95	3.63
16.0	1.98	143.52	142.97	142.54	3.53	3.39	3.10





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-34.25	-42.75	-65.41	0.00
2.0	-36.42	-42.92	-64.59	0.01
3.0	-38.72	-43.72	-60.89	0.01
4.0	-41.00	-44.17	-55.67	0.01
5.0	-43.44	-44.44	-54.77	0.02
6.0	-46.04	-45.37	-54.04	0.02
7.0	-49.29	-45.96	-53.46	0.02
8.0	-50.51	-46.51	-52.51	0.02
9.0	-49.68	-47.51	-51.68	0.01
10.0	-47.94	-48.44	-51.60	0.00
11.0	-46.08	-49.42	-50.42	0.01
12.0	-44.60	-50.27	-49.77	0.01
13.0	-43.33	-51.50	-49.00	0.00
14.0	-42.10	-52.10	-48.60	0.00
15.0	-40.92	-53.75	-47.92	0.01
16.0	-39.86	-55.03	-47.36	0.03



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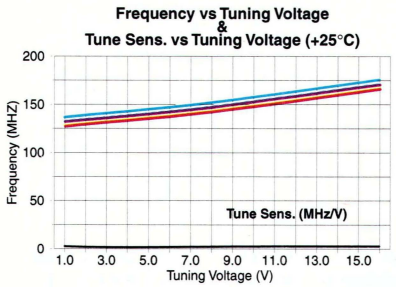
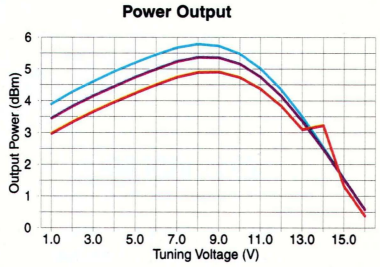
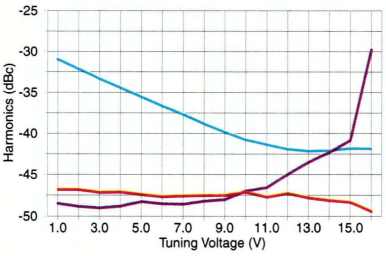
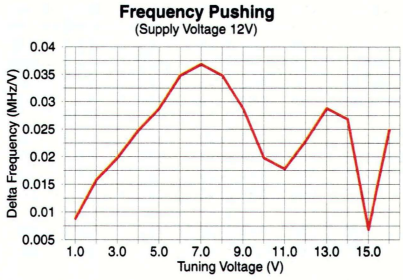


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	2.87	133.90	133.26	132.69	3.92	3.49	3.01
2.0	2.19	136.10	135.45	134.87	4.30	3.87	3.37
3.0	1.99	138.10	137.44	136.85	4.63	4.20	3.70
4.0	1.96	140.08	139.40	138.78	4.94	4.49	4.00
5.0	2.01	142.11	141.41	140.76	5.22	4.78	4.28
6.0	2.15	144.29	143.56	142.87	5.48	5.04	4.54
7.0	2.33	146.66	145.89	145.17	5.70	5.28	4.78
8.0	2.54	149.30	148.43	147.69	5.81	5.41	4.93
9.0	2.73	151.96	151.17	150.41	5.76	5.40	4.94
10.0	2.87	154.83	154.04	153.28	5.51	5.20	4.77
11.0	2.94	157.78	156.98	156.21	5.05	4.79	4.41
12.0	3.01	160.81	159.99	159.20	4.37	4.17	3.86
13.0	3.03	163.86	163.03	162.21	3.54	3.39	3.13
14.0	3.06	166.92	166.09	165.26	2.58	2.51	3.26
15.0	3.06	169.97	169.15	168.34	1.58	1.56	1.34
16.0	2.98	172.93	172.14	171.34	0.62	0.61	0.41





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-30.83	-48.33	-46.67	0.01
2.0	-32.04	-48.70	-46.70	0.02
3.0	-33.20	-48.87	-47.03	0.02
4.0	-34.32	-48.66	-46.99	0.03
5.0	-35.45	-48.11	-47.28	0.03
6.0	-36.54	-48.37	-47.54	0.04
7.0	-37.59	-48.43	-47.43	0.04
8.0	-38.72	-48.06	-47.39	0.04
9.0	-39.71	-47.88	-47.38	0.03
10.0	-40.68	-46.85	-47.01	0.02
11.0	-41.26	-46.43	-47.59	0.02
12.0	-41.81	-44.81	-47.14	0.02
13.0	-42.03	-43.36	-47.69	0.03
14.0	-42.00	-42.17	-48.00	0.03
15.0	-41.72	-40.72	-48.22	0.01
16.0	-41.77	-29.60	-49.27	0.03



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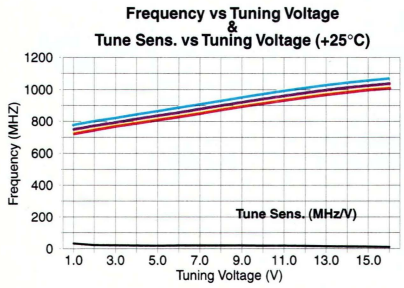
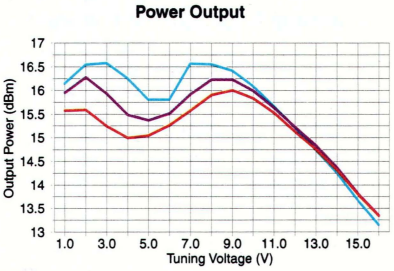
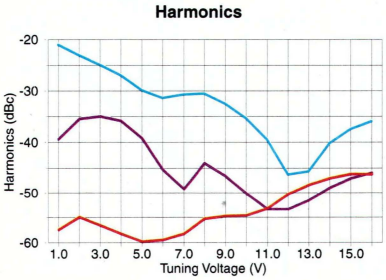
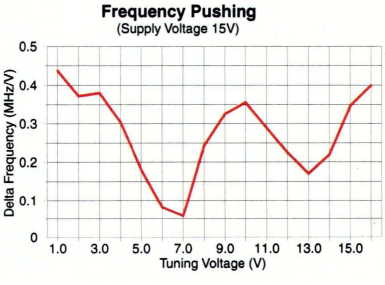


V TUNE	TUNING SENS. (MHz/V)	FREQUENCY (MHz) -55°C	+25°C	+85°C	POWER OUTPUT (dBm) -55°C	+25°C	+85°C
1.0	33.54	759.88	756.01	752.26	16.16	15.97	15.59
2.0	23.33	784.47	779.34	776.66	16.56	16.30	15.61
3.0	22.12	804.49	801.46	798.47	16.59	15.95	15.26
4.0	21.09	826.22	822.55	819.18	16.27	15.50	15.01
5.0	20.51	847.23	843.05	839.42	15.82	15.39	15.06
6.0	20.74	868.54	863.80	859.85	15.82	15.53	15.28
7.0	21.51	890.38	885.31	880.98	16.58	15.94	15.59
8.0	21.53	912.27	906.84	902.61	16.57	16.25	15.92
9.0	21.11	933.89	927.95	923.68	16.43	16.25	16.02
10.0	20.68	954.72	948.63	944.22	16.11	16.01	15.85
11.0	19.77	974.59	968.40	963.92	15.68	15.65	15.54
12.0	18.61	993.27	987.01	982.49	15.23	15.24	15.14
13.0	17.14	1010.55	1004.15	999.52	14.76	14.85	14.77
14.0	15.37	1026.12	1019.52	1014.67	14.27	14.38	14.33
15.0	13.35	1039.70	1032.88	1027.72	13.69	13.84	13.82
16.0	11.20	1051.14	1044.08	1038.61	13.16	13.36	13.35





V TUNE	HARMONICS (dBc) F2	F3	F4	FREQ. PUSHING (MHz/V)
1.0	-20.88	-39.26	-57.31	0.44
2.0	-22.92	-35.29	-54.82	0.37
3.0	-24.74	-34.80	-56.46	0.38
4.0	-26.81	-35.64	-58.10	0.31
5.0	-29.65	-39.05	-59.69	0.18
6.0	-31.20	-45.16	-59.34	0.08
7.0	-30.53	-49.06	-58.12	0.06
8.0	-30.33	-43.90	-55.13	0.24
9.0	-32.34	-46.44	-54.60	0.33
10.0	-35.16	-49.95	-54.52	0.36
11.0	-39.39	-53.21	-53.10	0.29
12.0	-46.15	-53.22	-50.12	0.23
13.0	-45.51	-51.36	-48.22	0.17
14.0	-40.11	-48.81	-46.91	0.22
15.0	-37.32	-46.90	-46.06	0.35
16.0	-35.77	-45.78	-46.11	0.40



VOLTAGE CONTROLLED OSCILLATORS

DUAL OUTPUT COAXIAL

ZOS

25 to 1025 MHz

MODEL NO.	FREQ. (MHz) Min.	Max.	POWER OUTPUT (dBm) Typ. Main.	Aux.	TUNE VOLTAGE (V) Min.	Max.	PHASE NOISE (dBc/Hz) SSB@ offset frequencies: Typ. 10 kHz	100 kHz	1MHz	PULLING (MHz) pk-pk @12 dBr (open/short) Typ.	PUSHING (MHz/V) Typ.	TUNING SENSITIVITY (MHz/V) Typ.	HARMONICS (dBc) Typ.	Max.	3 dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD Curves and Tables Pg.#(s)	CASE STYLE Note B	PRICE $ Qty. (1-9)
ZOS-50	25	50	+9	-12	1	16	-107	-126	-141	0.012	0.08	2.5	-22	-12	100	12	140	108-109	BR386	119.95
ZOS-75	37.5	75	+9	-12	1	16	-110	-128	-142	0.016	0.15	3.5	-26	-20	100	12	140	108-109	BR386	119.95
ZOS-100	50	100	+9	-12	1	16	-111	-131	-143	0.026	0.25	4.5	-29	-20	100	12	140	108-109	BR386	119.95
ZOS-150	75	150	+9	-12	1	16	-107	-127	-142	0.017	0.39	5.8	-23	-17	100	12	140	108-109	BR386	119.95
ZOS-200	100	200	+10	-11	1	16	-106	-126	-141	0.015	0.42	7.7	-25	-20	100	12	140	108-109	BR386	119.95
ZOS-300	150	280	+9	-13	1	16	-103	-123	-142	0.017	0.50	11	-27	-20	100	12	140	108-109	BR386	119.95
ZOS-400	200	380	+10	-13	1	16	-100	-120	-136	0.021	0.50	15	-24	-18	100	12	140	108-109	BR386	119.95
ZOS-535	300	525	+9	-13	1	16	-96	-118	-131	0.018	0.50	18	-27	-20	100	12	140	108-109	BR386	119.95
ZOS-765	485	765	+8.5	-14	1	16	-96	-117	-132	0.033	0.72	22	-27	-17	100	12	140	108-109	BR386	119.95
ZOS-1025	685	1025	+8	-13	1	16	-92	-112	-136	0.051	1.00	30	-25	-18	100	12	140	108-109	BR386	119.95

NOTES:

A. General Quality Control Procedures, Environmental specifications, Hi-Rel, and MIL description are given in Mini-Circuits RF/IF Designer's Guide.

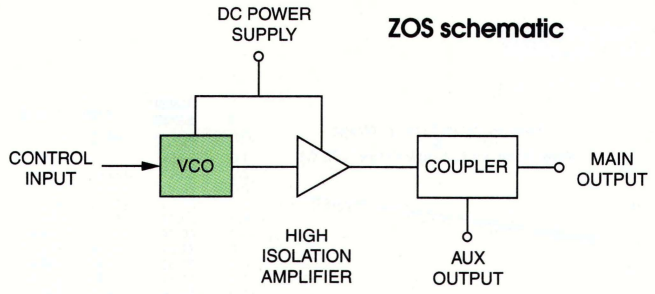
B. Connector types, case mounted options, and case finishes are given with "Outline Drawings & Case Style Dimensions" on pages 112 and 113.

C. Prices and Specifications subject to change without notice.

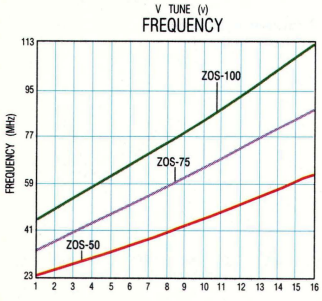
1. Absolute Maximum Supply Voltage (V_{cc}) & Tuning Voltage (V_{tune}):
2. Operating Temperature: -55°C to +85°C

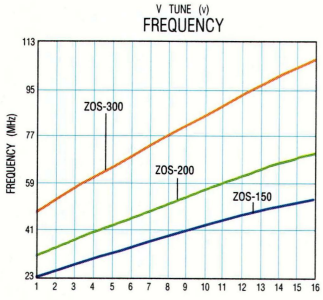
Model	(V_{cc})	(V_{tune})
ZOS Models	+16V	+18V
except ZOS-50	+16V	+17V

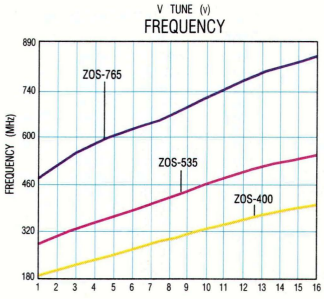
ZOS schematic

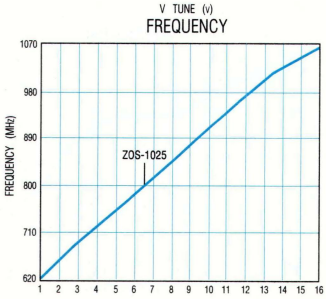


ZOS PERFORMANCE CURVES









ZOS PERFORMANCE DATA

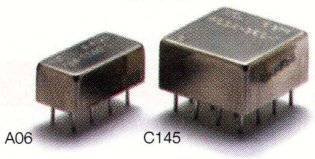
Dual Output - *(see specs on previous page)*

ZOS Models	Performance Parameter	Tuning Voltage (V) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
-50	FREQ.(MHz)	23.50	25.91	28.11	30.20	32.31	34.53	36.90	39.43	42.10	44.86	47.66	50.53	53.40	56.30	59.21	62.08
	P_{OUT} MAIN (dBm)	9.31	10.12	10.17	10.11	10.00	9.82	9.60	9.33	9.02	8.66	8.27	7.87	7.46	7.05	6.61	6.20
	P_{OUT} AUX (dBm)	-12.65	-11.76	-11.40	-11.41	-11.45	-11.57	-11.75	-11.96	-12.18	-12.38	-12.67	-12.99	-13.28	-13.50	-13.86	-14.13
	2NDHARM (dBc)	-19.65	-19.30	-19.84	-20.45	-21.50	-22.49	-23.94	-25.50	-27.67	-30.30	-33.74	-38.17	-44.90	-47.31	-41.55	-38.14
-75	FREQ.(MHz)	32.55	36.15	39.81	43.16	46.48	49.83	53.38	56.95	60.58	64.25	67.95	71.75	75.58	79.46	83.30	87.01
	P_{OUT} MAIN (dBm)	9.17	9.99	9.86	9.70	9.52	9.33	9.12	8.87	8.60	8.32	8.01	7.71	7.40	7.09	6.81	6.53
	P_{OUT} AUX (dBm)	-12.92	-11.94	-11.58	-11.70	-11.80	-12.03	-12.16	-12.28	-12.47	-12.70	-12.91	-13.14	-13.36	-13.64	-13.78	-14.01
	2NDHARM (dBc)	-27.16	-23.33	-24.03	-24.85	-25.83	-26.46	-27.23	-27.80	-28.37	-28.75	-28.77	-28.65	-28.33	-27.85	-27.90	-28.12
-100	FREQ.(MHz)	44.10	48.55	53.01	57.00	60.88	64.85	68.97	73.26	77.73	82.38	87.12	91.98	96.88	101.76	106.67	111.52
	P_{OUT} MAIN (dBm)	9.93	10.09	9.98	9.89	9.78	9.69	9.57	9.42	9.28	9.11	8.93	8.71	8.53	8.33	8.13	7.94
	P_{OUT} AUX (dBm)	-12.25	-11.43	-11.42	-11.49	-11.59	-11.63	-11.72	-11.84	-11.89	-12.02	-12.13	-12.25	-12.31	-12.46	-12.67	-12.87
	2NDHARM (dBc)	-28.74	-27.06	-27.26	-27.49	-27.88	-28.29	-28.67	-29.02	-29.21	-29.87	-30.86	-31.62	-32.10	-32.38	-32.81	-32.28
-150	FREQ.(MHz)	71.82	78.35	84.79	91.14	97.10	103.00	108.90	114.78	120.62	126.32	131.80	137.00	141.86	146.35	150.49	154.22
	P_{OUT} MAIN (dBm)	9.69	10.17	9.99	9.88	9.79	9.70	9.60	9.49	9.36	9.23	9.10	8.96	8.82	8.70	8.55	8.43
	P_{OUT} AUX (dBm)	-12.22	-11.45	-11.35	-11.46	-11.54	-11.61	-11.69	-11.76	-11.83	-11.97	-12.10	-12.18	-12.26	-12.37	-12.49	-12.58
	2NDHARM (dBc)	-27.29	-23.77	-24.75	-25.29	-25.52	-25.90	-25.95	-26.15	-26.36	-26.74	-27.10	-27.44	-27.79	-28.49	-28.99	-29.87
-200	FREQ.(MHz)	94.83	102.66	110.86	118.55	125.90	133.28	140.76	148.30	156.00	163.56	171.06	178.31	185.01	191.46	197.45	202.80
	P_{OUT} MAIN (dBm)	10.05	10.40	10.39	10.36	10.28	10.18	10.09	10.00	9.87	9.75	9.66	9.56	9.46	9.37	9.30	9.25
	P_{OUT} AUX (dBm)	-12.03	-11.27	-11.15	-11.16	-11.22	-11.28	-11.35	-11.48	-11.58	-11.64	-11.78	-11.85	-11.91	-12.03	-12.06	-12.12
	2NDHARM (dBc)	-28.13	-23.61	-23.06	-22.86	-23.12	-23.84	-24.41	-24.79	-25.47	-26.32	-26.89	-27.29	-27.52	-27.75	-28.17	-28.24
-300	FREQ.(MHz)	140.88	154.48	166.25	177.26	187.63	198.85	209.53	221.15	232.70	243.51	255.20	266.06	275.51	284.78	293.80	301.78
	P_{OUT} MAIN (dBm)	8.85	9.42	9.53	9.60	9.71	9.68	9.65	9.61	9.65	9.59	9.46	9.32	9.24	9.14	9.03	8.96
	P_{OUT} AUX (dBm)	-14.73	-13.51	-13.13	-13.10	-13.01	-12.89	-12.97	-13.02	-13.06	-13.12	-13.21	-13.28	-13.39	-13.43	-13.67	-13.73
	2NDHARM (dBc)	-29.83	-51.35	-37.59	-33.84	-30.94	-30.38	-29.80	-29.44	-28.47	-28.69	-29.37	-30.03	-30.44	-30.49	-31.53	-32.27
-400	FREQ.(MHz)	188.51	206.23	221.73	236.00	250.63	265.86	280.43	296.53	312.45	326.91	339.70	354.71	368.11	379.78	389.98	398.81
	P_{OUT} MAIN (dBm)	9.99	10.24	10.37	10.44	10.44	10.33	10.15	10.01	9.95	9.95	9.95	9.72	9.56	9.41	9.28	9.15
	P_{OUT} AUX (dBm)	-12.23	-12.05	-11.89	-11.80	-11.82	-12.00	-12.22	-12.39	-12.50	-12.51	-12.52	-12.86	-13.02	-13.20	-13.36	-13.50
	2NDHARM (dBc)	-23.71	-21.72	-21.04	-20.74	-21.03	-21.38	-22.02	-22.99	-24.06	-24.70	-25.17	-25.88	-26.89	-28.22	-30.60	-31.56
-535	FREQ.(MHz)	285.70	310.26	330.60	348.36	365.80	383.18	400.80	416.96	438.38	461.06	480.18	497.68	513.36	526.45	535.45	546.08
	P_{OUT} MAIN (dBm)	8.81	9.25	9.47	9.59	9.71	9.70	9.60	9.48	9.20	9.17	9.15	8.96	8.83	8.56	8.25	8.00
	P_{OUT} AUX (dBm)	-13.80	-13.41	-13.25	-13.18	-13.10	-13.09	-13.24	-13.40	-13.73	-13.81	-13.85	-14.05	-14.23	-14.50	-14.81	-15.12
	2NDHARM (dBc)	-30.14	-29.70	-27.37	-26.61	-25.72	-25.83	-25.85	-25.38	-26.07	-27.02	-27.78	-28.24	-29.07	-30.11	-30.67	-31.58
-765	FREQ.(MHz)	477.80	518.50	552.11	580.51	604.58	625.96	644.60	659.96	692.20	721.35	746.93	770.05	790.50	808.60	824.46	838.33
	P_{OUT} MAIN (dBm)	8.07	8.50	8.67	8.93	8.74	8.75	8.72	8.53	8.46	7.97	7.84	7.68	7.34	7.03	6.72	6.47
	P_{OUT} AUX (dBm)	-14.68	-14.38	-14.26	-14.10	-14.11	-14.26	-14.34	-14.60	-14.65	-15.07	-15.53	-15.49	-15.68	-15.98	-16.62	-16.96
	2NDHARM (dBc)	-30.20	-29.40	-28.91	-27.49	-27.76	-27.27	-26.41	-26.23	-27.14	-28.02	-29.37	-30.25	-30.58	-31.43	-32.50	-33.24
-1025	FREQ.(MHz)	625.46	663.05	691.83	720.73	751.21	781.83	810.83	843.43	877.01	907.96	940.21	973.75	1002.18	1025.31	1044.81	1061.70
	P_{OUT} MAIN (dBm)	9.24	9.17	9.22	9.01	8.68	8.64	8.65	8.37	8.26	8.12	7.85	7.75	7.72	7.68	7.65	7.52
	P_{OUT} AUX (dBm)	-12.87	-12.31	-12.31	-12.46	-12.60	-12.68	-12.77	-12.90	-12.95	-12.98	-13.03	-13.16	-13.13	-13.04	-13.07	-13.05
	2NDHARM (dBc)	-23.08	-23.55	-25.07	-25.56	-25.20	-27.57	-29.74	-28.96	-28.21	-28.09	-28.07	-28.22	-28.76	-27.89	-28.03	-28.20

VOLTAGE CONTROLLED OSCILLATORS

Additional Performance Data From Our Engineering Database*

PLUG-IN

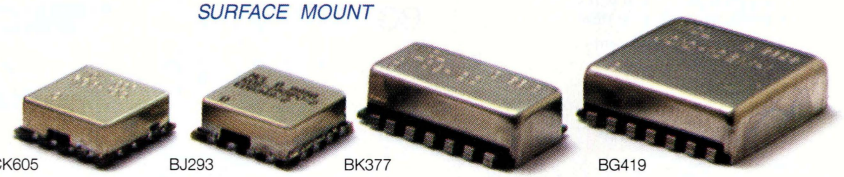


75 to 3192 MHz

REFERENCE NO.	FREQUENCY COVERAGE (MHz)		TUNE VOLTAGE (V)		PULLING (MHz) pk-pk @12 dBr	PUSHING (MHz/V)	3 dB MOD. BANDWIDTH (kHz)	POWER SUPPLY		CAPD DATA FOR ADDITIONAL PARAMETERS	CASE STYLE
	Min.	Max.	Min.	Max.	Typ.	Typ.	Typ.	Voltage (V) Nom.	Current (mA) Max.		
POS-ED5319/1	75	114	0.5	7.0	0.50	1.30	200	5	15		A06
ROS-ED6923/1	99	113	0.3	7.0	0.10	0.15	2000	5	20		CK605
POS-ED4782A/1	114	149	1.0	18.0	0.04	0.02	2000	12	25		C145
POS-ED6684/1	123	271	1.0	20.0	0.50	0.30	1000	12	20		A06
POS-ED4783A/1	134	175	1.0	18.0	0.05	0.03	2000	12	25		CK145
ROS-ED6770/3	161	240	1.0	15.0	0.50	0.10	400	12	30		CK605
JYOS-ED5398/3	164	259	0.5	5.0	1.10	3.20	95	3	10		BJ293
ROS-EDR4294	182	253	0.5	13.0	0.20	0.50	1700	12	20		CK605
JTOS-ED4905/12	184	249	0.3	6.0	0.07	1.30	120	5	15		BK377
JTOS-ED6869/2	197	444	1.0	20.0	0.60	0.20	260	12	25		BK377
JYOS-ED5788	237	354	0.5	7.0	2.60	3.00	220	3	10		BJ293
JTOS-ED5955A/2	232	419	0.5	11.0	0.40	0.10	140	12	20		BK377
ROS-ED6845/4	329	388	0.5	7.0	1.00	0.30	1000	12	50		CK605
ROS-EDR4239/2	336	369	0.5	5.0	2.00	0.20	1000	11	12	FOR	CK605
POS-ED4638/1	322	473	0.5	7.0	1.40	1.30	50	5	20	DATA	A06
JTOS-ED5563/1	323	478	0.5	10.0	0.90	1.50	450	12	25	SEE YONI	BK377
JYOS-ED6587/2	377	499	0.5	7.0	0.60	0.60	100	5	18	ON OUR	BJ293
JTOS-ED5769/2	386	835	1.0	15.0	4.40	1.30	100	10	25	WEBSITE	BK377
ROS-EDR4268	395	489	0.5	5.0	1.50	0.50	330	5	10		CK605
JTOS-ED6579/6	423	997	1.0	19.0	9.60	4.80	100	5	15		BK377
JTOS-ED4883/5	439	532	0.3	5.0	1.30	0.60	420	10	25		BK377
JTOS-ED6124/2	491	753	0.5	6.0	4.10	3.10	750	5	30		BK377
POS-ED5634B/2	450	1152	0.3	19.0	6.00	1.50	100	12	20	YONI™	A06
ROS-EDR4142	501	533	0.5	5.0	3.50	0.50	2200	5	8		CK605
JROS-ED5930A/1	476	794	0.3	6.0	3.70	4.70	2000	7	15		CK605
ROS-ED6757/2	621	682	1.0	20.0	0.70	0.50	1000	12	35		CK605
JCOS-ED6046/3	701	798	0.5	8.0	0.40	0.40	2000	8	30		BG419
JCOS-ED5427/1	717	779	1.0	15.0	0.20	0.50	2000	12	25		BG419
JCOS-ED6707/7	737	809	0.5	8.0	2.50	1.00	2000	10	35		BG419
JCOS-ED6304/4	769	858	1.0	10.0	3.40	0.60	2000	5	22		BG419
JCOS-ED6304A/2	773	917	1.0	8.0	2.70	0.50	2000	5	30		BG419
ROS-EDR4133	769	834	0.5	5.0	0.70	1.00	2000	5	13		CK605
JCOS-ED6772A/1	772	848	0.3	7.0	2.50	0.07	2000	10	25		BG419
ROS-EDR4134	786	860	0.5	5.0	0.50	0.30	2000	5	17		CK605
JCOS-ED6517A/3	796	931	1.0	15.0	2.00	0.30	2000	9	30		BG419
ROS-EDR4135	818	895	0.5	5.0	1.00	0.50	2000	5	18		CK605
POS-ED5507/2	779	975	1.0	15.0	6.50	1.10	300	12	25		A06
JCOS-ED6865/2	849	1013	1.0	15.0	1.00	0.02	2000	11	30		BG419
ROS-EDR4217/2	884	921	0.5	10.0	1.20	0.80	2000	5	10		CK605
JTOS-ED5197/3	889	958	1.0	8.0	4.40	0.60	2000	12	25		BK377

***THESE ARE NON-STOCK MODELS. CONSULT APPLICATIONS DEPARTMENT FOR FINAL SPECIFICATIONS.**
SMALL QUANTITY DELIVERY 6 WEEKS AFTER ORDER ACCEPTANCE

SURFACE MOUNT



CK605 BJ293 BK377 BG419

REFERENCE NO.	FREQUENCY COVERAGE (MHz) Min.	Max.	TUNE VOLTAGE (V) Min.	Max.	PULLING (MHz) pk-pk @12 dBr Typ.	PUSHING (MHz/V) Typ.	3dB MOD. BANDWIDTH (kHz) Typ.	POWER SUPPLY Voltage (V) Nom.	Current (mA) Max.	CAPD DATA FOR ADDITIONAL PARAMETERS	CASE STYLE
ROS-EDR4295	912	983	0.5	5.0	0.50	0.05	2500	5	27		CK605
POS-ED6986/1	910	1884	1.0	25.0	15.00	2.80	5000	12	28		A06
ROS-ED6824/3	840	1529	1.0	12.0	25.00	5.00	2000	5	25		CK605
ROS-EDR4293	899	1900	1.0	25.0	20.00	3.00	2500	12	17		CK605
JTOS-ED5496/1	1025	1741	1.0	25.0	50.00	2.00	2000	8	30		BK377
ROS-EDR4296	1044	1103	0.5	5.0	0.50	0.50	2500	5	25		CK605
JTOS-ED6640/3	1025	1098	0.3	5.0	0.90	0.10	2000	10	30		BK377
JCOS-ED5151B/2	1064	1138	0.3	9.0	1.00	0.09	2000	8	40		BG419
ROS-EDR4039	1074	1118	0.5	5.0	15.00	2.50	2500	5	8		CK605
ROS-EDR4266	1124	1718	2.0	20.0	26.00	2.00	2500	8	27		CK605
JCOS-ED4735/1	1062	1132	1.0	8.0	1.90	0.60	2000	8	35		BG419
ROS-EDR4255/2	1206	1317	0.5	5.0	0.40	2.00	2500	5	32		CK605
ROS-EDR4348	1220	1337	1.0	5.0	0.50	1.50	2500	5	35		CK605
JTOS-ED4715B/2	1225	1289	0.5	6.0	4.60	0.50	2000	5	25	FOR	BK377
JTOS-ED5346/3	1270	2130	1.0	25.0	40.00	1.50	1000	8	30	DATA	BK377
ROS-EDR3979/4	1360	1417	0.3	5.0	3.50	2.00	2500	5	24	SEE YONI	CK605
ROS-ED6756/2	1486	1672	0.5	10.0	1.10	1.50	2000	5	25	ON OUR	CK605
ROS-EDR4347	1430	1554	0.5	5.0	1.00	1.80	2500	5	23		CK605
ROS-EDR4298	1531	1671	0.5	5.0	0.50	0.90	2500	5	23	WEBSITE	CK605
ROS-EDR4318	1544	1840	0.5	5.0	20.00	3.00	2500	5	16		CK605
JTOS-ED6924/14	1595	2710	1.0	15.0	12.00	2.00	2000	12	35		BK377
ROS-EDR4259	1606	2034	1.0	20.0	20.00	1.50	2500	8	27		CK605
ROS-EDR4179/2	1646	1740	1.0	9.0	25.00	3.00	2500	8	21		CK605
ROS-EDR4247	1705	1801	1.0	9.0	5.00	3.00	2500	8	22		CK605
ROS-ED6981/2	1706	1854	0.5	5.0	14.00	2.50	1600	5	25		CK605
JTOS-ED6281/3	1668	2558	0.5	10.0	10.00	2.50	2000	12	25		BK377
JTOS-ED6817	1679	2827	1.0	16.0	11.00	1.50	3000	12	30		BK377
JTOS-ED6530/2	1714	1864	0.5	5.0	13.00	8.00	2000	8	25		BK377
ROS-EDR4249	1823	1946	0.5	8.0	5.00	4.00	2000	8	22		CK605
ROS-EDR4248	1881	2013	1.0	9.0	5.00	2.50	2000	8	22		CK605
JTOS-ED6120/3	1886	2394	0.5	8.0	15.00	5.00	10000	5	25		BK377
ROS-EDR4284/1	2018	2140	0.5	5.0	1.00	1.00	2500	5	21		CK605
ROS-ED6794/2	2151	2841	0.5	7.0	35.00	1.50	10000	5	25		CK605
ROS-EDR4297	2197	2336	0.5	5.0	1.00	3.00	2500	5	20		CK605
JTOS-ED6531/1	2191	2507	1.0	15.0	8.00	0.70	2000	10	30		BK377
ROS-EDR4154	2903	3192	0.5	5.0	20.00	5.00	2500	5	18		CK605

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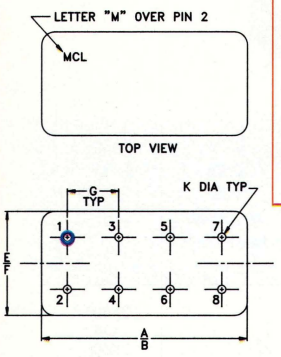
www.minicircuits.com

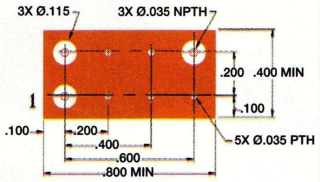
OUTLINE DRAWINGS AND FOOTPRINTS

A



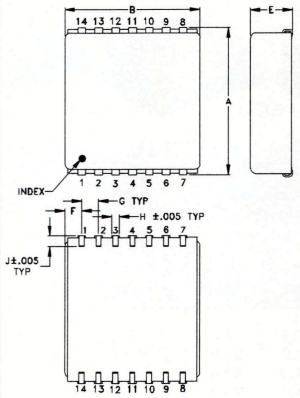
NOTE: BLUE BEAD INDICATES PIN 1.
PIN NUMBERS DO NOT APPEAR ON UNIT, FOR REFERENCE ONLY.

SUGGESTED LAYOUT FOR PCB PATTERN
"hx" PIN CONNECTION (TOP VIEW) / PL-013

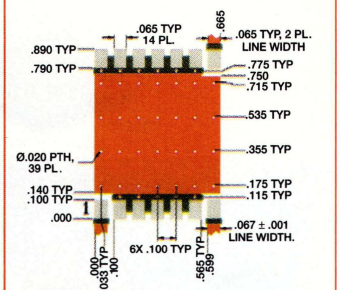


DENOTES METALLIZATION
RECOMMENDED MATERIAL: ROGERS R04350
THICKNESS: .030 ± .002; COPPER: 1/2 OZ ON EACH SIDE

BG

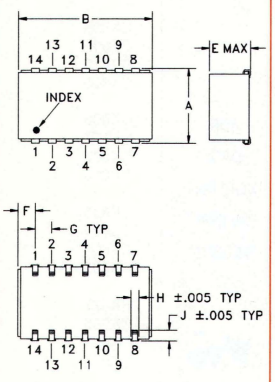


SUGGESTED LAYOUT FOR PCB PATTERN
"jd" PIN CONNECTION / PL-011

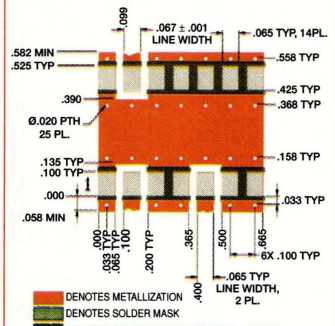


DENOTES METALLIZATION
DENOTES SOLDER MASK
DENOTES SOLDER MASK OVER METALLIZATION
DENOTES METALLIZATION FOR DEVICE SOLDERING
RECOMMENDED MATERIAL: ROGERS R04350,
DIELECTRIC THICKNESS: .030 ± .002
COPPER: 1/2 OZ. EACH SIDE

BK

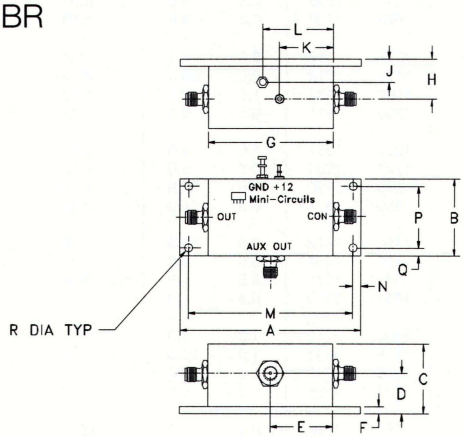


SUGGESTED LAYOUT FOR PCB PATTERN
"jc" PIN CONNECTION / PL-005

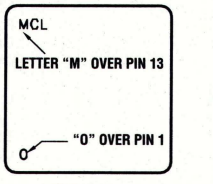


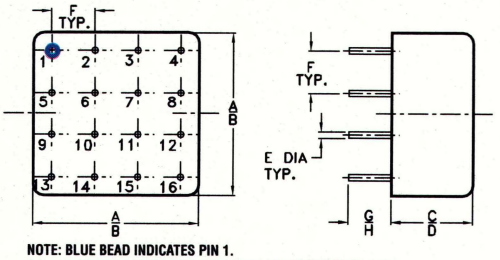
DENOTES METALLIZATION
DENOTES SOLDER MASK
DENOTES SOLDER MASK OVER METALLIZATION
DENOTES METALLIZATION FOR DEVICE SOLDERING
RECOMMENDED MATERIAL: ROGERS R04350
DIELECTRIC THICKNESS: .030 ± .002
COPPER: 1/2 OZ. ON EACH SIDE

BR



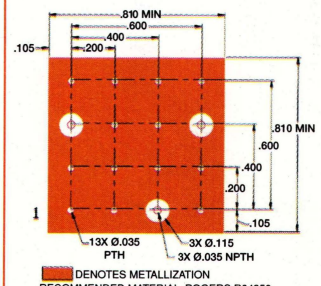
C





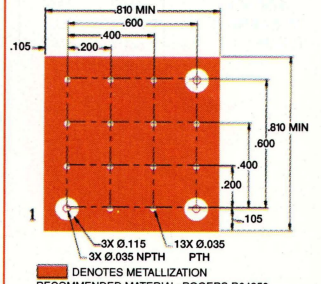
NOTE: BLUE BEAD INDICATES PIN 1.
PIN NUMBERS DO NOT APPEAR ON UNIT, FOR REFERENCE ONLY.

SUGGESTED LAYOUT FOR PCB PATTERN
"jr" PIN CONNECTION (TOP VIEW) / PL-021

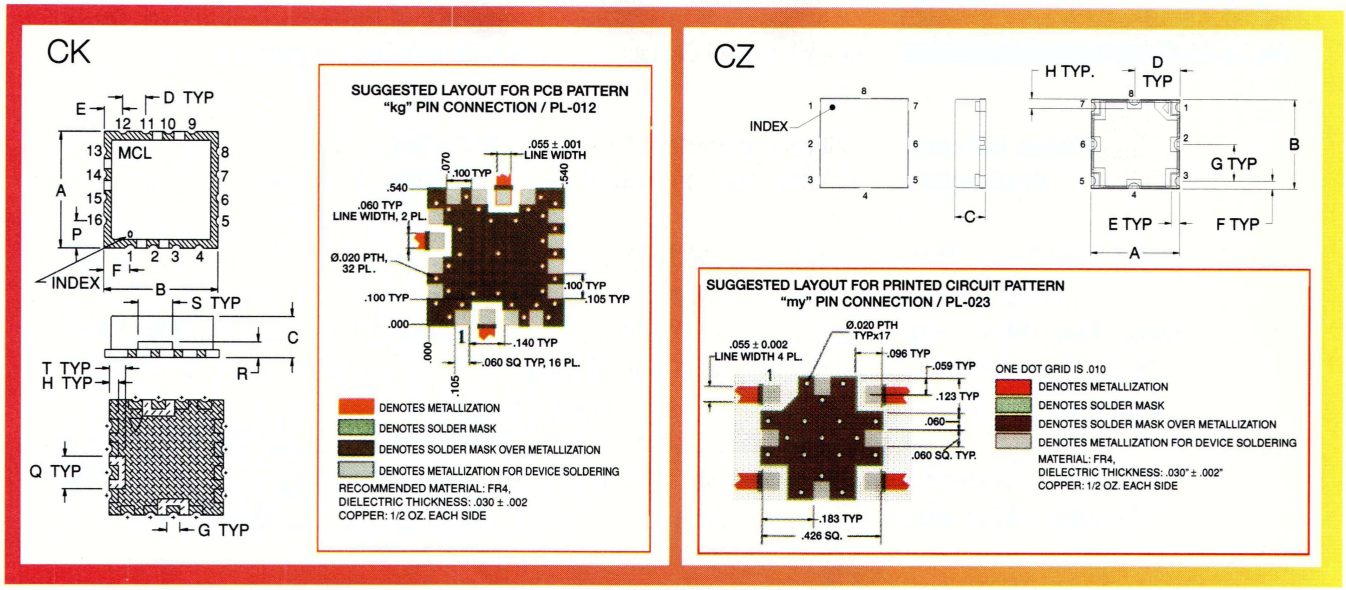


DENOTES METALLIZATION
RECOMMENDED MATERIAL: ROGERS R04350,
DIELECTRIC THICKNESS: .030 ± .002
COPPER: 1/2 OZ. EACH SIDE

SUGGESTED LAYOUT FOR PCB PATTERN
"mj" PIN CONNECTION (TOP VIEW) / PL-022



DENOTES METALLIZATION
RECOMMENDED MATERIAL: ROGERS R04350,
DIELECTRIC THICKNESS: .030 ± .002
COPPER: 1/2 OZ. EACH SIDE



LAYOUT CONSIDERATIONS TO IMPROVE PERFORMANCE

Three basic types of VCOs are manufactured by Mini-Circuits: Plug-in, Surface Mount, and Connectorized versions. To obtain the best overall performance from Mini-Circuits VCOs, good RF practices should be used. A double sided printed circuit board with plated through holes is recommended. For Mini-Circuits VCOs with "Plug-in" case style, the metallization on the top side of the PCB, on which units are mounted, should be left, as far as possible, as a continuous "ground plane" with low impedance. For Mini-Circuits VCOs with "Surface Mount" case style: the metallization on the bottom side of the PCB, which is opposite to the side the VCOs are mounted, should be left as a continuous "ground plane" with low impedance. For both "Plug-in" and "Surface Mount" Mini-Circuits VCOs, the printed conductors which carry RF and microwave signals (output pin of the VCO) should be designed as 50 ohm characteristic impedance microstrip lines where the width of the lines should be calculated in accordance with dielectric constant (ϵ_r) and thickness of PCB substrate. For PCB layouts and materials, refer to "Outline Drawings and Footprints". Similar material from other vendors can be used. If the ground plane needs to be broken, it is important to support each microstrip line with a corresponding ground plane on the opposite side of the board. This ground plane should be at least three times wider than the width of the microstrip line itself. It is recommended that pin V_{CC} be bypassed to the ground plane as close to the VCO as possible. See suggested PCB layouts on these two pages, or consult Mini-Circuits for additional details.

CASE STYLE DIMENSIONS

OUTLINE DIMENSIONS (inch / mm)

case no.	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	wt. grams	NOTES*
	.770	.800	.285	.310	.370	.400	.200	.20	.14	.031									5.2	A1, B3, E1, B7
A06	19.56	20.32	7.24	7.87	9.40	10.16	5.08	5.08	3.56	.79										
	.870	.800	--	--	.400	.100	.100	.047	.065										6.4	A27
BG419	22.09	20.32	--	--	10.16	2.54	2.54	1.19	1.65											
	.505	.789	--	--	.250	.095	.100	.047	.065										3.0	A27, F28
BK377	12.83	20.04	--	--	6.35	2.41	2.54	1.19	1.65											
	3.25	1.38	1.25	.71	1.13	.125	2.25	.71	.41	.98	1.28	2.950	.15	1.100	.14	.150			180	A4, A18, D17
BR386	82.55	35.05	31.75	18.03	28.70	3.18	57.15	18.03	10.41	24.89	32.51	74.93	3.81	27.94	3.56	3.81				
	.770	.810	.380	.410	.030	.200	.20	.14											11.0	A1, E1, B7
C07	19.56	20.57	9.65	10.41	.76	5.08	5.08	3.56												
	.500	.500	.180	.100	.080	.115	.060	.040	--	--	--	--	--	.115	.140	.070	.150	.070	1.0	A31, F37
CK605	12.70	12.70	4.57	2.54	2.03	2.92	1.52	1.02	--	--	--	--	--	2.92	3.56	1.78	3.81	1.78		
	.375	.375	.131	.188	.035	.033	.154	.040											.60	A31, F60
CZ682	9.52	9.52	3.33	4.78	0.89	0.84	3.91	1.02												

tolerance .x± .1 .xx± .03 .xxx± .015 inch **oz. = grams x .0353**

*NOTES:

MATERIAL AND FINISH

A1. Header material: C.R.S. Pin material: #52 alloy. Finish: Electro tin, hot-oil flowed. Cover Material: Cupro-nickel.
A4. Case material: Aluminum alloy. Finish: Irridite per MIL-C-5541.
A18. Mounting bracket finish: Irridite or clear anodize.
A27. Header: Glass epoxy laminate. Cover Material: Nickel-silver alloy. Leads: Solder-plated iron-nickel alloy.
A31. Case material: Nickel-silver alloy. Header: G-10 base. Termination finish: Solder plate.

MOUNTING

B3. Insulated spacer available. Request P/N B14-045-01.
B7. Pin's meniscus (of header): 0.015" max.

CONNECTORS

D17. Connectors: Female SMA only.

SPECIAL TOLERANCES

E1. Pin diameter: ± .005 inch.

PACKAGING

F1-60. Tape & Reel packaging available. See Tape & Reel packaging information for details. To order Tape & Reel version add -TR suffix to model number.

PARAMETER SPECIFICATIONS CHECKLIST

Voltage Controlled Oscillators

If your particular requirements for a VCO are not met with an existing Mini-Circuits item, please complete the checklist below and mail, phone or fax it to Mini-Circuits, Applications Engineering Department.

Please Indicate: Critical Parameter ✔✔ Important ✔

Application: ☐ Industrial/Commercial ☐ Military ☐ Space

Oscillator Frequency Range: _____ MHz to _____ MHz

Tuning Voltage: _____ (Min.) _____ (Max.)

Output Power (Sinusoidal): _____ dBm (Typ.) _____ dBm (Min.) / _____ dBm (Max.)

Output Power Variation: _____ dB Peak To Peak

Harmonic Suppression: 2nd: –_____ dBc ☐ Typ. ☐ Max.
3rd: –_____ dBc ☐ Typ. ☐ Max., 4th: –_____ dBc ☐ Typ. ☐ Max.

Tuning Sensitivity: _____ MHz/V (Typ.) _____ MHz/V (Min.) /_____ MHz/V (Max.)

Modulation Bandwidth: _____ kHz _____ (Typ.) _____ (Min.)

DC Supply Voltage: _____ Volts

DC Supply Current: _____ mA (Max.)

Phase Noise:

Offset Freq.	*SSB Noise Level*	*Offset Freq.*	*SSB Noise Level*
_____ Hz	_____ dBc/Hz	_____ Hz	_____ dBc/Hz
_____ Hz	_____ dBc/Hz	_____ Hz	_____ dBc/Hz

Frequency Pulling (12 dB Ret. Loss): _____ MHz Peak-Peak ☐ Typ. ☐ Max.

Frequency Pushing : _____ MHz/V ☐ Typ. ☐ Max.

Operating Temperature: _____ to_____ (°C)

Storage Temperature: _____ to_____ (°C)

Output Load: 50 Ohms

Package: ☐ Surface Mount ☐ Plug In ☐ Connector
☐ *BNC* ☐ *TNC* ☐ *SMA* ☐ *Type N*
☐ *Other* _____

Case Style: ☐ Existing _____ ☐ New _____

Hermeticity Required: ☐ Yes ☐ No

Water Wash Required: ☐ Yes ☐ No

Special Requirements: _____

_____

Name _____

Title _____

Company _____ Dept. _____

Company Address _____

Phone _____ Fax _____ email _____

Mini-Circuits PARTNER PROGRAM®

Mini-Circuits®

GUARANTEED SAVINGS...YEAR IN AND YEAR OUT!

Your long term business allows us to invest in improved production procedures. As a result, we can continually improve quality, shorten delivery times and lower the costs of production.

As partners, we both share in these benefits and savings.

IMAGINE... Each and every year you make a purchase, you save money!

IMAGINE... Discounts apply to large and small quantity buyers and annual contracts

IMAGINE... Savings apply to all catalog models and most custom products

IMAGINE... This program is retroactive to your first purchase

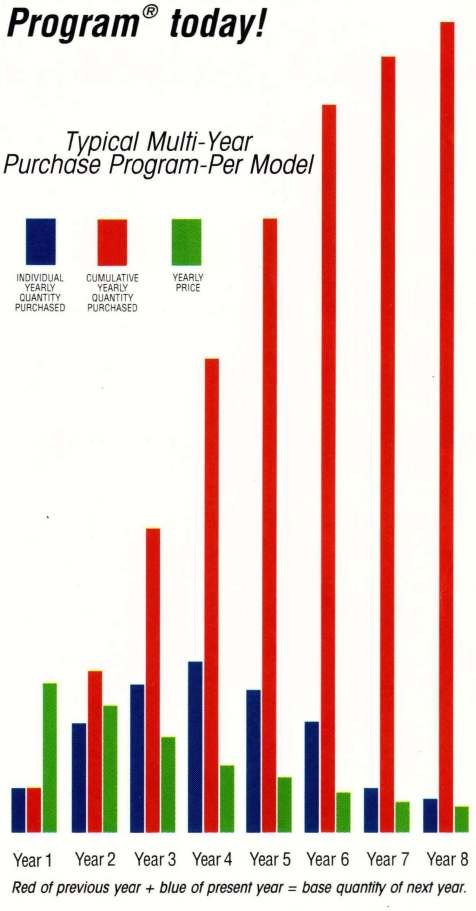
IMAGINE... You don't have to maintain inventories with the Partner Program®

Now, here's how to start saving with the Partner Program® today!

Here's How The Program Works:

Each consecutive year you purchase a quantity of a particular Mini-Circuits model *(blue bar)*...those quantities add-up *(red bar)*. The price you pay today is based on the cumulative quantities of all your previous annual purchases, plus your current purchase. With the *Partner Program®*, all of your past purchases add-up to earn higher quantities and correspondingly lower prices on your purchase now *(green bar)*.

Typical Multi-Year Purchase Program-Per Model



Red of previous year + blue of present year = base quantity of next year.

Now that's guaranteed savings!

With Mini-Circuits *Partner Program®* you can enjoy a lifetime of volume quantity price reductions on all our catalog models and most of our custom products.

The Partner Program® makes sense

Today, everyone is talking about the highly competitive business environment and global challenges. In typical Mini-Circuits tradition, we're not talking...we're taking action. The *Partner Program®* is our way of sharing risks and earning the rewards of doing business with you. The end result...lower costs. As partners, we both share in these savings. *That's what true partnership is all about!*

How to join the Partner Program®

The program is limited to qualified customers and governed by the "Terms & Conditions". There is no cost or obligation. Simply make a purchase from Mini-Circuits...we'll take care of all the details and manage the statistics for your account. You can place your order in the usual manner with Mini-Circuits. Your purchases will be tallied and tracked in our computer. You will be eligible to receive automatic discounts based on your cumulative purchases.

Start saving with your very next order...***JOIN THE PARTNER PROGRAM® TODAY!***

*For "Terms & Conditions" or additional information about the **Partner Program®** contact Mini-Circuits or visit our web site*

see us on the web
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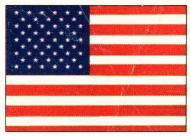
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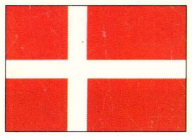
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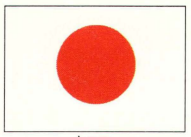
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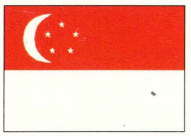
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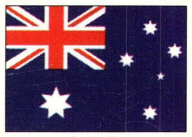
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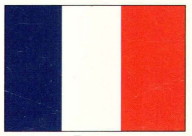
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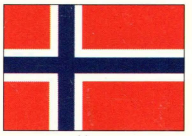
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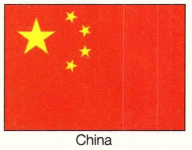
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